Luminescent Dissolved Oxygen for Water Analysis

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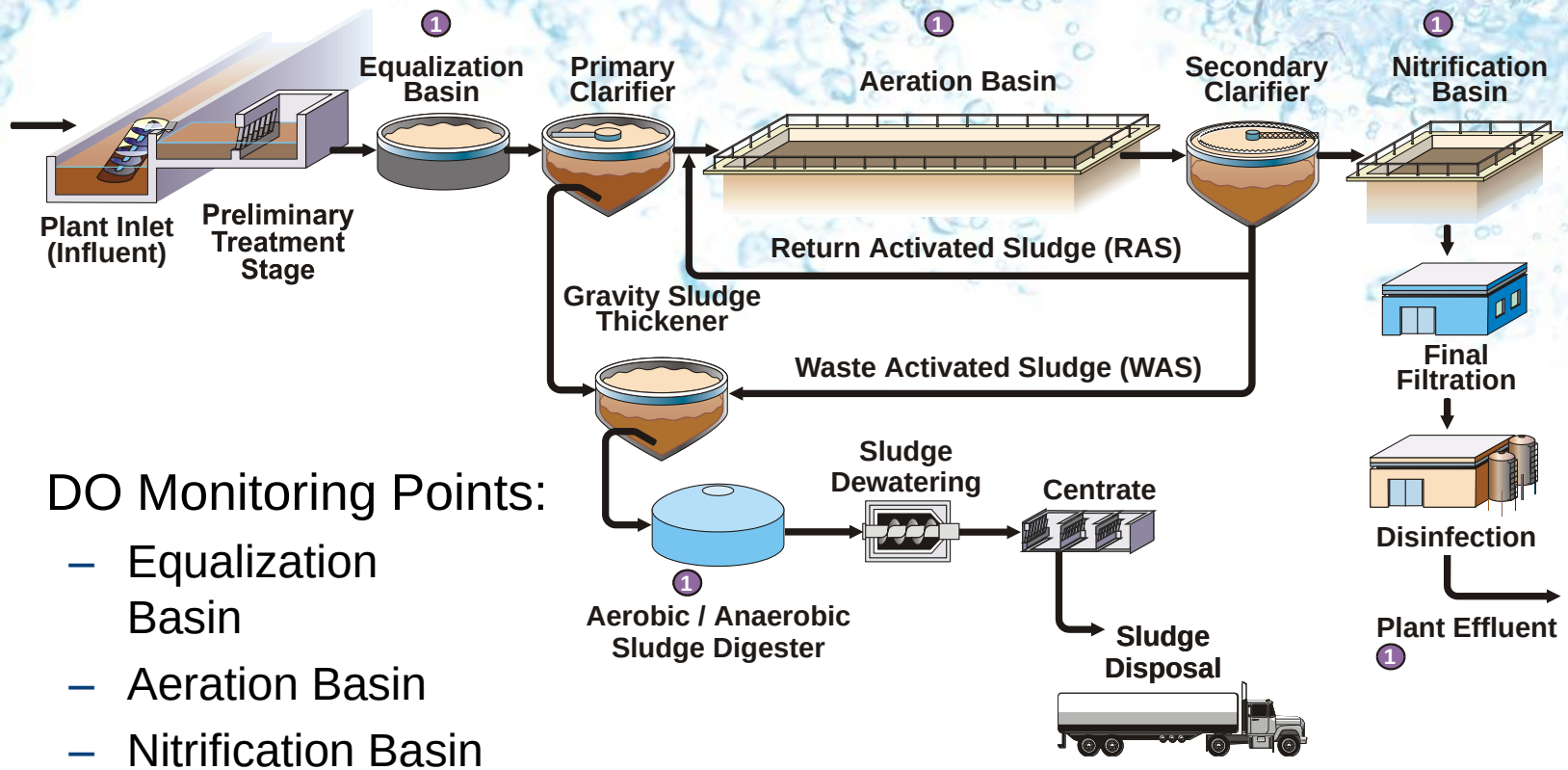
Today's Agenda

1. Where DO is measured
2. BOD Analysis
3. Galvanic Dissolved Oxygen Analysis
4. Luminescent Dissolved Oxygen Analysis
5. Products Available for Measurement
6. Time for Q&A

Where is DO Measured?



- DO Monitoring Points:
  - Equalization Basin
  - Aeration Basin
  - Nitrification Basin
  - Aerobic/Anaerobic Digester
  - Plant Effluent
  - Lakes/Streams, etc.

BOD: What is it?

- Biochemical Oxygen Demand is a measure of organic pollution
- A measurement of the oxygen demand impact of effluent into a receiving body; measures all oxygen demand including nitrogen-based oxygen demand

In other words…

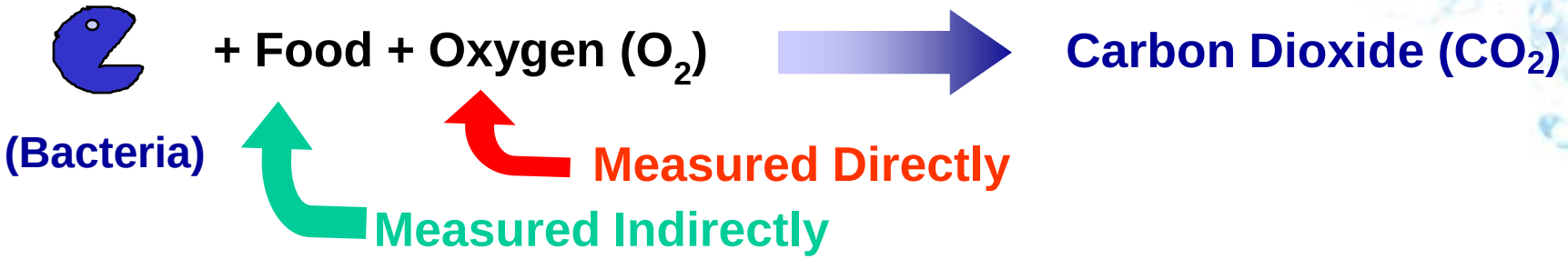
- BOD measurements help in monitoring the effect of effluent on the dissolved oxygen concentration of the receiving water body

What is BOD?

- Biochemical Oxygen Demand: How much oxygen the bugs in your sample consume
- BOD_5 is the most common form of US EPA-Based testing
  - "5" is the number of days between initial and final measurements of DO
  - BOD_7 is a similar test that monitors over seven days
- Required in the US for water discharge: industrial release, wastewater treatment, etc.
- Used globally as a best practice for water discharge testing

BOD: How is it measured?

- BOD is measured by oxidizing organics using microorganisms (under specific conditions) and directly measuring the amount of oxygen consumed in the process.



- Changes in dissolved oxygen concentration are used as an indirect measure of organic content (food)

- BOD is the amount of oxygen, expressed in mg/L bacteria take from the water when they oxidize organic matter.

BOD: Why do we do it??

Top 5 reasons:

1. We have to!
2. It's on our permit
3. Week-by-week barometer of how the overall plant is performing
4. Historical data on the plant to know how seasonality plays into plant performance
5. We have to!!

BOD & cBOD: Any concerns?

Average number of hours/week a typical WW facility spends on BOD?	15 hours
Average number of bottles set per week for BOD?	20 - 40
Average number of times per week BOD is run?	2 sets
Percent of BOD tests that FAIL to meet Standard Methods Guidelines?	**5-10%**

Is there a better way?

- Failure of standards can often be traced to issues with membrane electrodes and calibrations
  - Oxygen consumptive reduction from an electrolyte and two metallic electrodes
  - Oxygen must diffuse through a membrane to be reduced at a cathode
- Limitations
  - Requires high flow across membrane
  - Narrow linearity range
  - Electrolyte and electrode degradation
  - Membrane fouling – must be changed frequently

Outline – Dissolved Oxygen

DO Measurement Techniques

- Luminescence (LDO)
- Galvanic

Galvanic DO Measurement

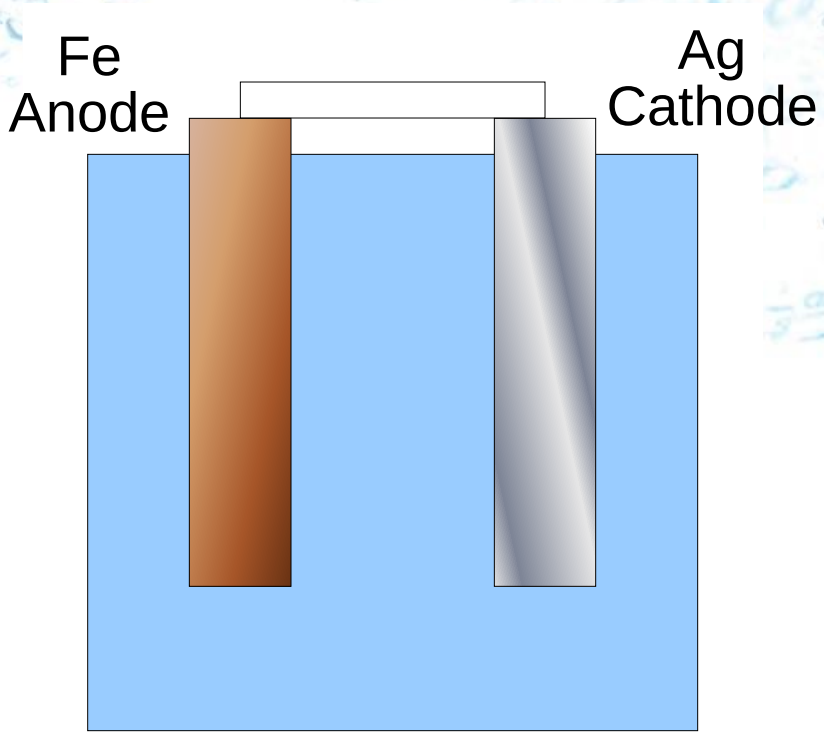
- A galvanic cell operates much like a battery!

Galvanic DO Measurement

- How does a galvanic sensor measure dissolved oxygen?

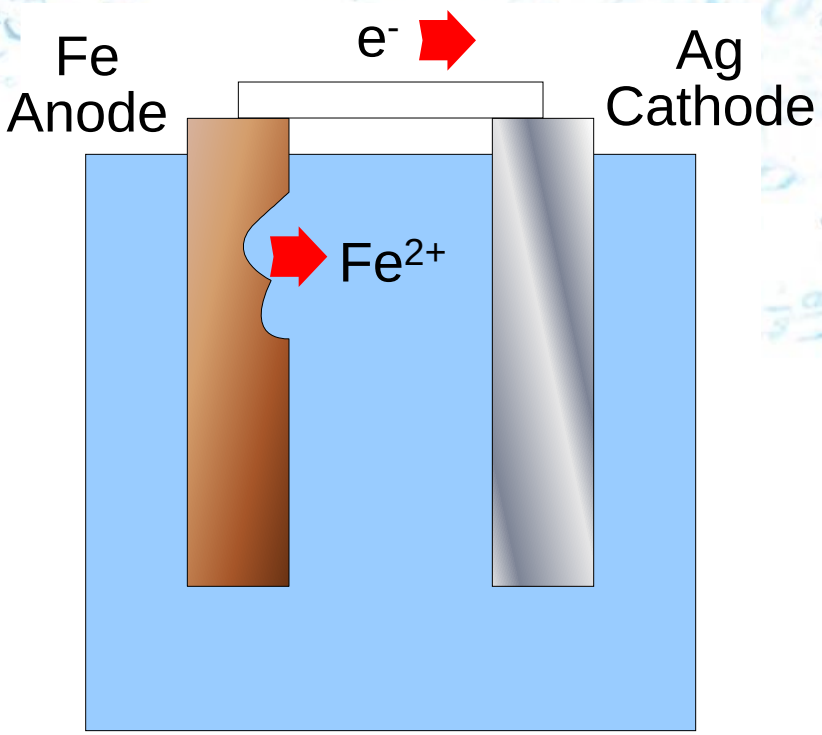
Galvanic DO Measurement

- Two electrodes of dissimilar metals are immersed in a filling solution.



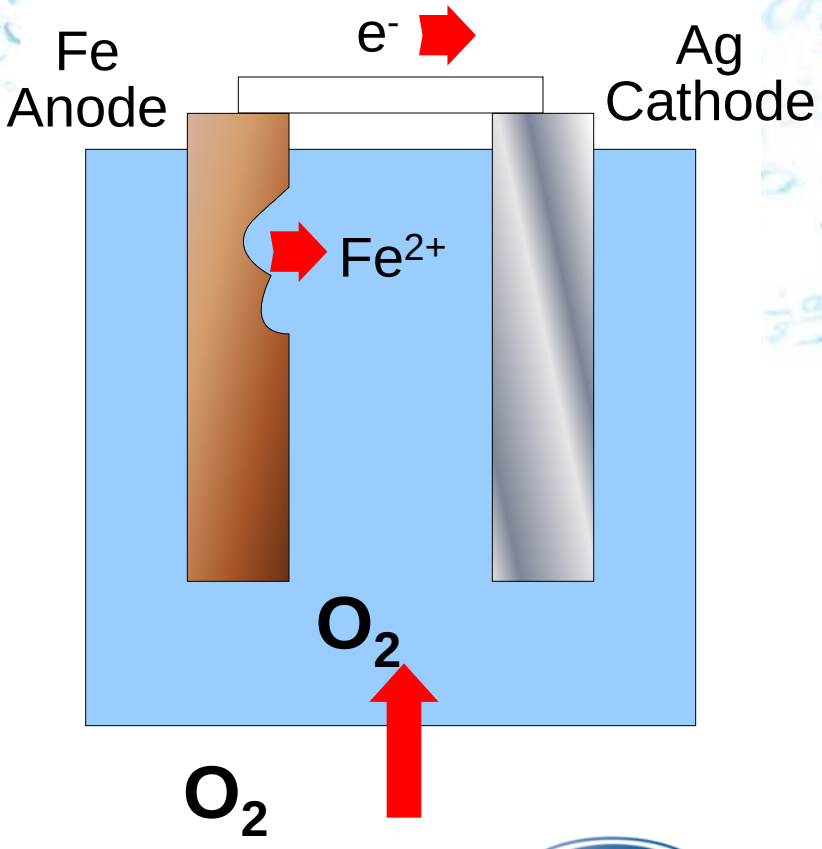
Galvanic DO Measurement

- A spontaneous reaction occurs between the two metals.



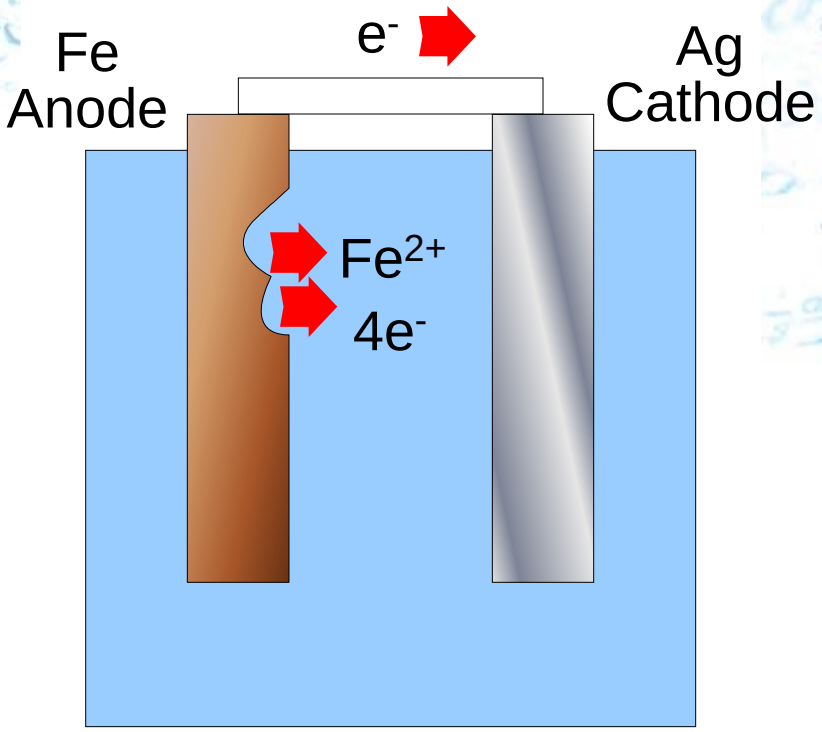
Galvanic DO Measurement

- Oxygen enters the cell through a membrane.



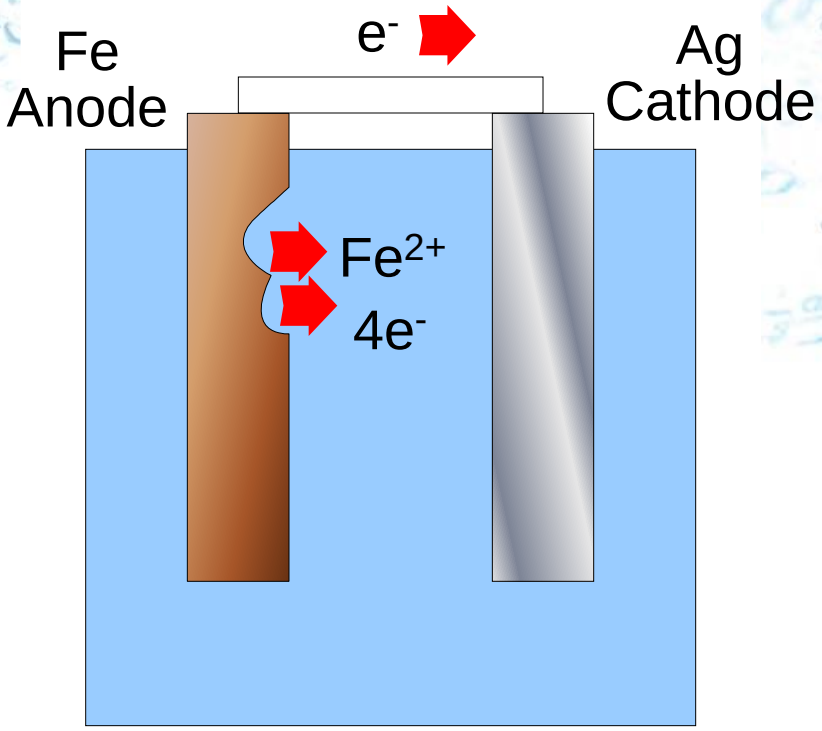
Galvanic DO Measurement

- Oxygen is reduced to hydroxide at the cathode.



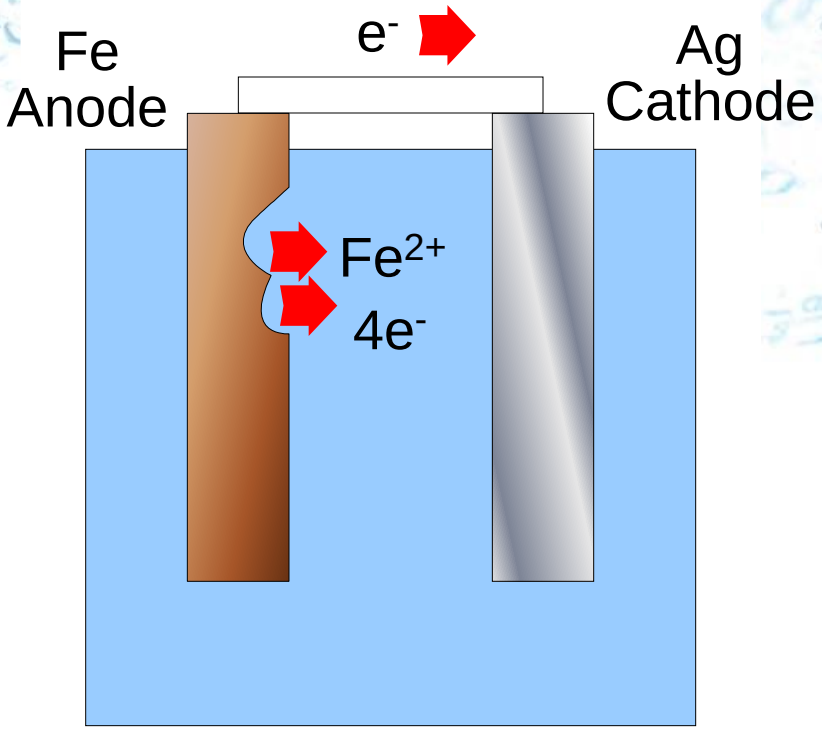
Galvanic DO Measurement

- Flow of current is proportional to the number of electrons produced at anode.



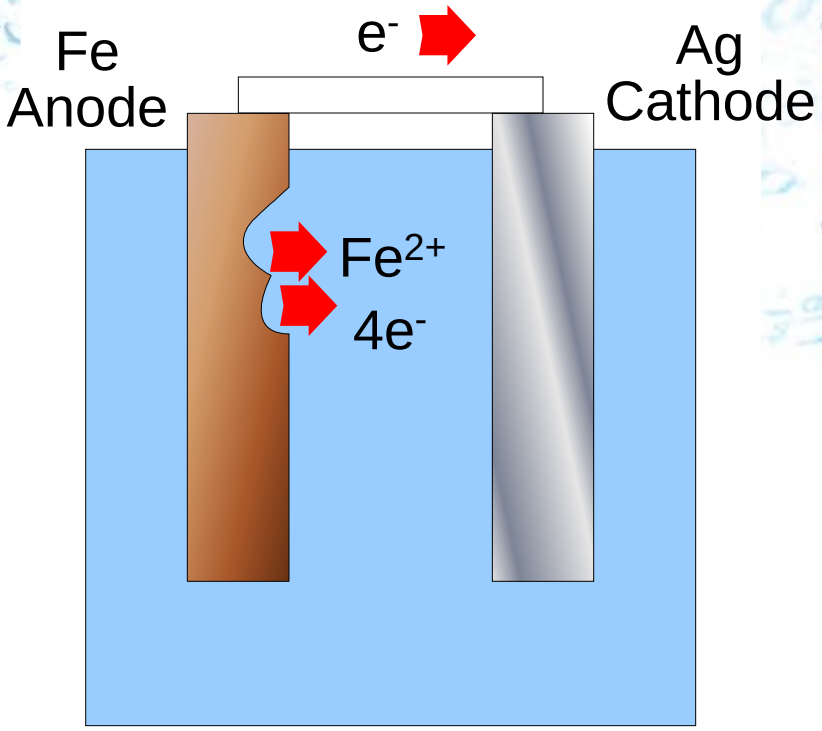
Galvanic DO Measurement

- The more oxygen in the sample:
  - The greater the current flow (voltage)



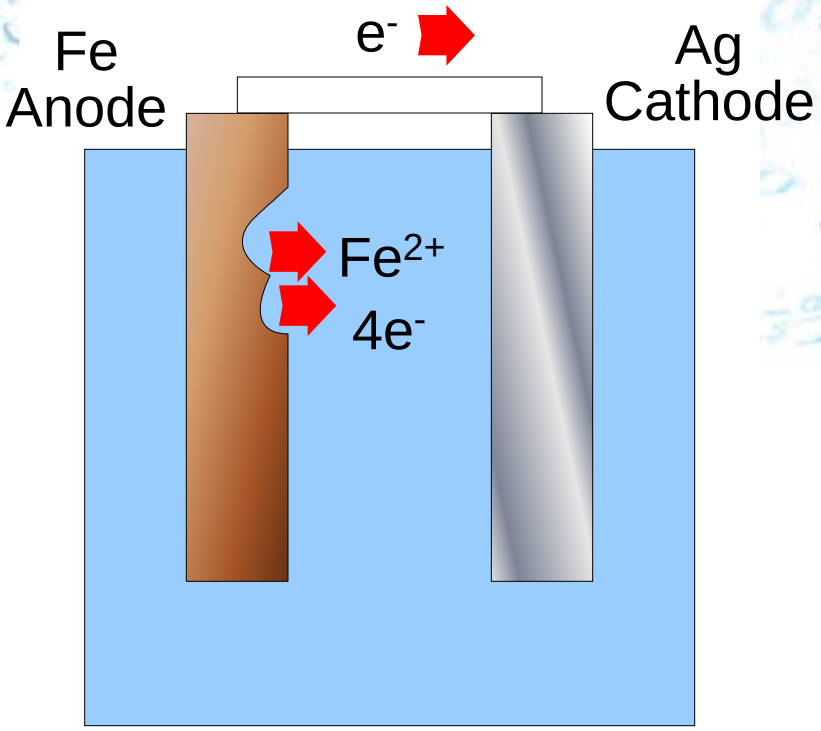
Galvanic DO Measurement

- The Voltage is converted to a mg/l, ppm or % saturation reading.



Galvanic DO Measurement

- The cell reaction destroys the electrolyte, the anode, and oxygen to complete the reading!

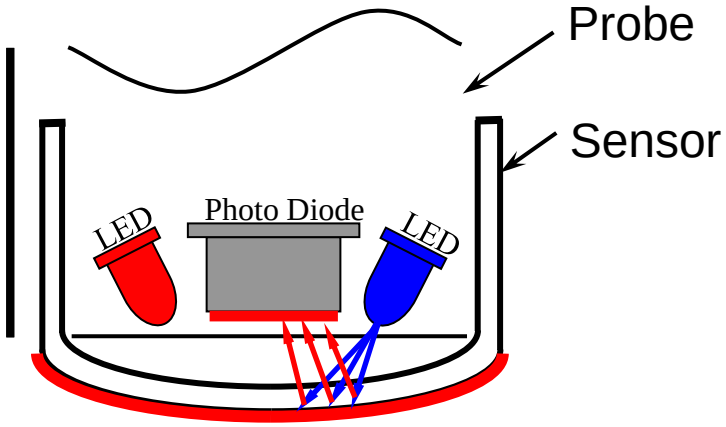


Outline – Dissolved Oxygen

- DO Measurement Techniques
  - Luminescence (LDO)
  - Galvanic

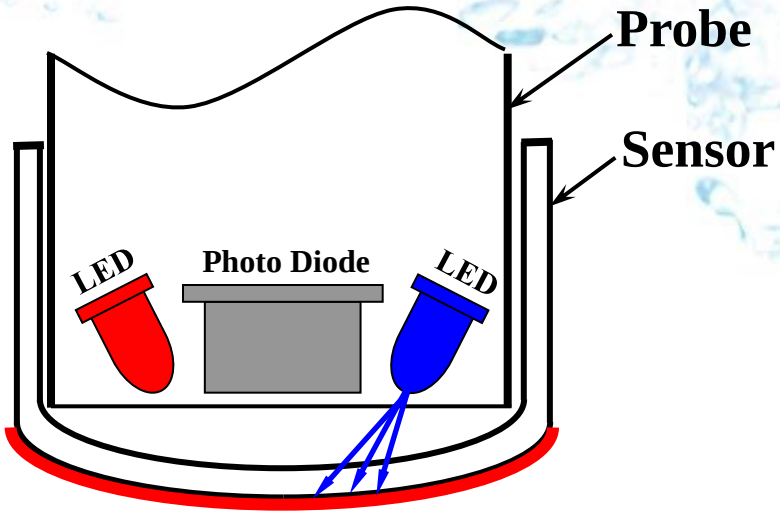
Luminescence Based Oxygen Sensors

- Measures the light emission characteristics of a reversible luminescent reaction
- In the presence of oxygen the luminescence is quantitatively reduced or quenched
- Dissolved oxygen concentration is inversely proportional to the luminescence lifetime of the light emitted by the photo-luminescence process



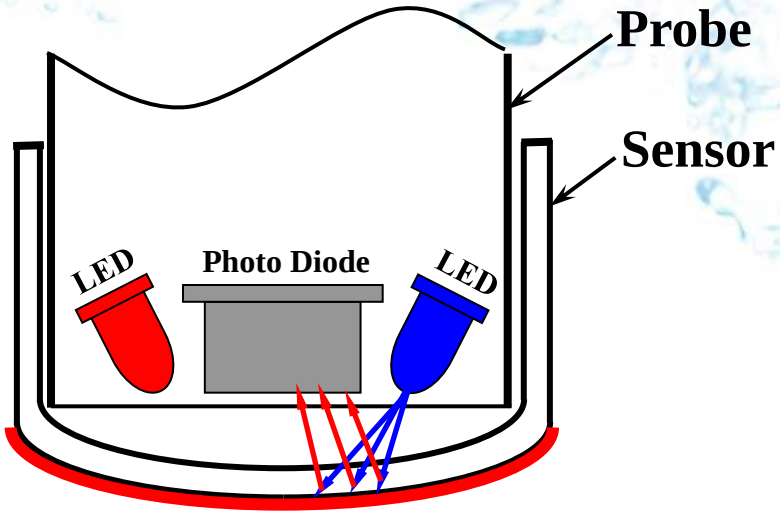
Luminescent DO

- A sensor is coated with a luminescent material.
- Blue light from an LED strikes the luminescent chemical on the sensor.
- The luminescent chemical instantly becomes excited.



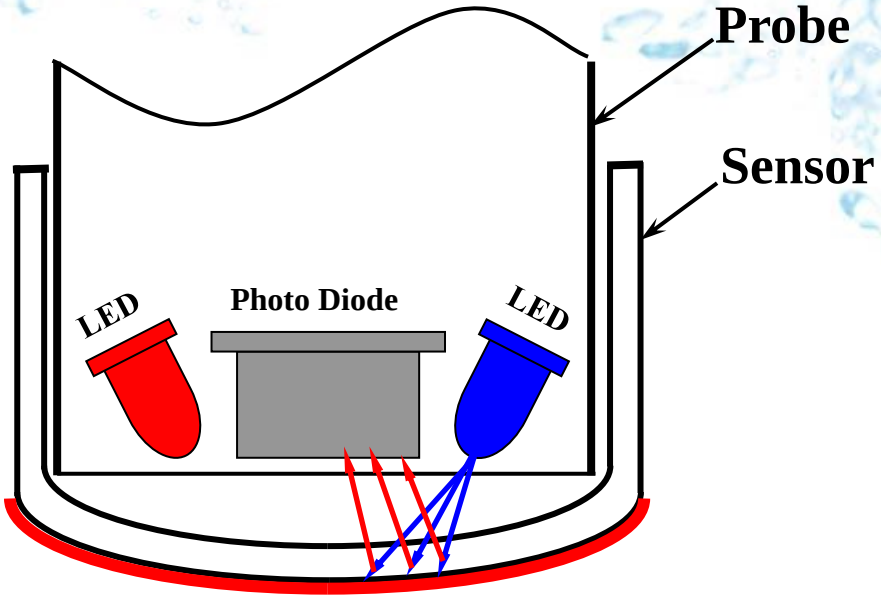
Luminescent DO

- As the excited chemical relaxes, it releases red light.
- The red light is detected by a photo diode.
- The time it takes for the chemical to return to a relaxed state is measured



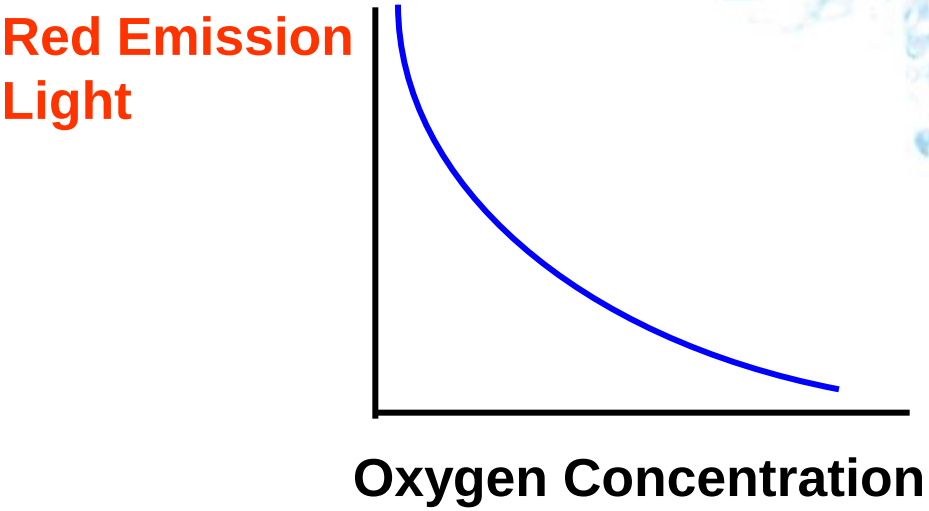
Luminescent DO

- When oxygen contacts the luminescent chemical, the intensity of the red light decreases
- The amount of time it takes for the material to relax is reduced



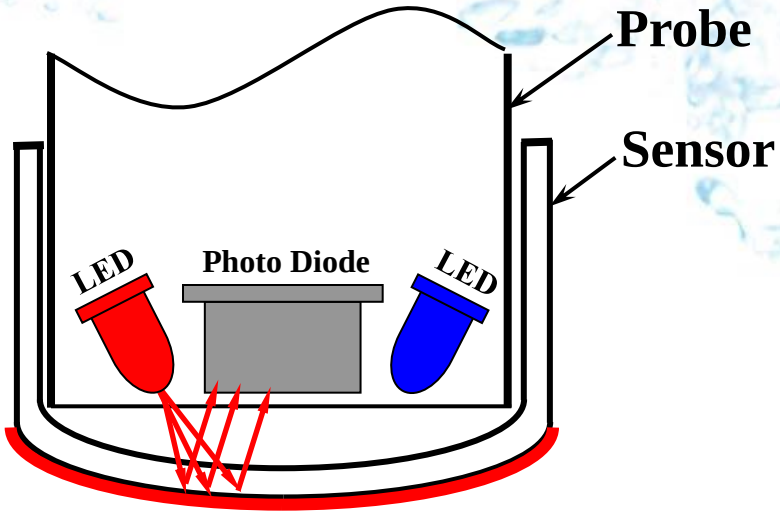
Luminescent DO

- The higher the oxygen concentration, the less red light that is given off by the sensor.



Luminescent DO

- A red LED is also present in the probe.
- Between flashes of the blue LED, a red LED of known intensity, is flashed on the sensor.
- The red LED acts as an internal standard (or reference) for a comparison to the red light given off by the luminescent chemical.



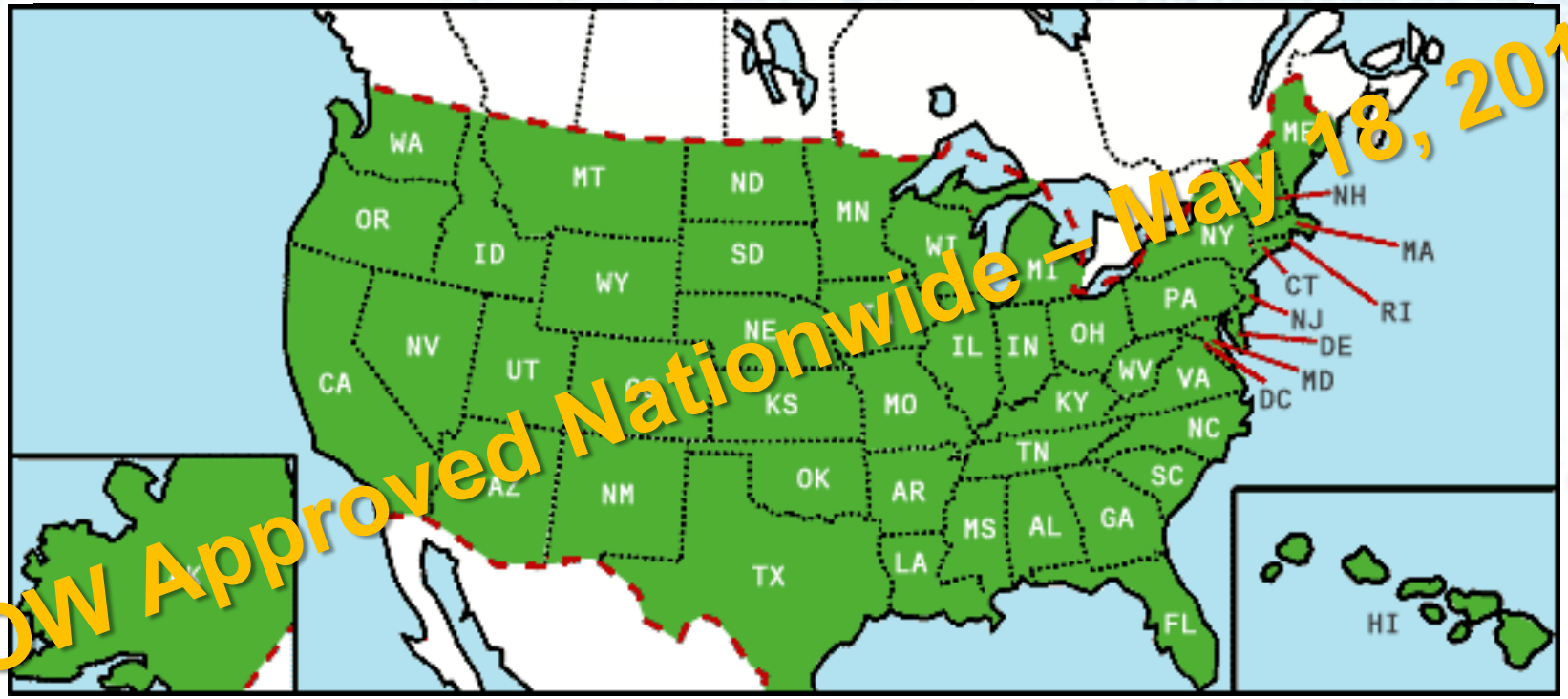
Advantages of Luminescent Technology

- Reduced Maintenance
  - No anode or cathode
    - No cleaning of anodes
    - No more coating of electrodes
  - No membrane to replace
    - No more stretching of Teflon and worrying about air bubbles
  - No Interferences from other chemicals
  - No electrolyte to foul or poison
    - No H_2S poisoning of the electrolyte
    - No more punctured membranes

Why is this a Big Deal?

- Accurate and Stable Readings
  - With nothing to interfere with the readings, LDO produces more stable measurements for a longer time
- Speed!
  - Turn it on and it's running!
  - Response time of less than 30 seconds to 90%!
- Simple Operation and Maintenance
  - Only one replacement part
  - Inexpensive sensor cap is simple to replace quickly

What about EPA Approval?



Green: **Approved** - No data needed

Blue: **Approved with Performance Data*** - Est. total time 2-8 Lab hrs/ 30-90 days

Orange: **Tier 1 Submission**

http://www.hach.com/hqdguide-do

How does LDO help reduce errors?

- Fast response and no sensor drift
  - No warm-up time
- Quick calibration in water saturated air
- No membrane to replace
  - No electrolyte to foul or poison
  - No more punctured membrane
- No H_2S poisoning of the electrolyte

Multiple sources of error eliminated from the BOD method!

IntelliCAL™ LBOD Probe

- LDO Technology
- Integrated stirrer
- Designed for the US EPA-Based Method of BOD5 Measurement
  - Critical Bottle Dimension: 0.625 inches (15.875 mm)
  - Can be used in any facility testing for BOD
- For use with the HQ40d Meter

HQ40d Portable Meter Kit with LBOD101 Luminescent Dissolved Oxygen (LDO) Probe for BOD Measurement

HQ440d Benchtop Meter Package with LBOD101 Dissolved Oxygen Probe for BOD Measurement

IntelliCAL™ LDO101 Standard Luminescent Dissolved Oxygen (LDO) Probe

IntelliCAL™ LDO101 Rugged Luminescent Dissolved Oxygen (LDO) Probe

Dissolved Oxygen:
Hach LDO® Probe, Model 2

Alternative Laboratory Methods for Analysis in WWTPs

Thank you very much!

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