



Blood Gas Analyzers

- During this presentation I will go over:
 - The purpose of blood gas analysis
 - I'll talk about the directly measured parameters
 - How and why we correct for certain environmental variables
 - The main components of a blood gas analyzer
 - 2 Point Calibration
 - Sequence of events during a 2 pt cal and a patient sample



FIRST, THE PURPOSE OF BLOOD GAS ANALYSIS

- BGA is used to determine the O₂ content, CO₂ content and pH (acidity) of a patient's blood sample.
- The analysis evaluates how effectively the lungs are delivering O₂ to the blood and how efficiently they are eliminating CO₂ from it.
- Also indicates how well the lungs and kidneys are interacting to maintain normal blood pH.
- Blood Gas Analysis is performed on blood retrieved from an **artery**, because veins are mostly devoid of oxygen.



DIRECTLY MEASURED PARAMETERS

- *Now, there are 3 parameters that all Blood Gas Analyzers measure directly from the patient sample:*
 - pO_2 (which stands for partial Oxygen)
 - pCO_2 (which stands for partial Carbon Dioxide)
 - pH (which does not stand for partial Hydrogen)
 - The analyzer is measuring the gas pressures that the oxygen and CO₂ gases are exerting in your blood.



- pO_2 is the measurement of the O_2 concentration in blood.
 - Checks how well the patient is “taking up” oxygen
 - Normal pO_2 -- 80 to 90 mmHg
 - Testing pO_2 is actually measuring how much oxygen the lungs are delivering to the blood.
- pCO_2 is the measurement of the CO_2 concentration in blood.
 - Normal pCO_2 -- 35 to 45 mmHg
- pCO_2 pressure indicates how well the lungs are eliminating carbon dioxide.
- pH is the measurement of acidic level of the blood and is defined as the negative log of the hydrogen ion concentration.
 - A pH of 7 is considered neutral (pure water).
 - A pH less than 7 is acidic with 1 being the most acidic.
 - A pH greater than 7 is basic with 14 being the most basic.
 - Normal blood pH is 7.35 - 7.45



Now since we're measuring gas pressures we have to correct for some environmental variables that have an effect on gas pressure.

- *Patient sample temperature*
- *Barometric pressure*
- *The water vapor pressure of our calibration gases.*



Correcting for Patient Sample Temperature

- *Gas pressure is affected by temperature.*
- *In a Blood Gas Analyzer, we don't want our patient sample results affected by differences in sample temperature, so the analyzers maintain the patient sample at 37°C.*



Correcting for Barometric Pressure

- *Gas pressure in liquids is affected by the gas pressure around the liquid (barometric pressure).*
 - *This is a factor that is constantly changing and needs to be corrected for.*
 - *The Blood Gas Analyzer continuously monitors barometric pressure and electronically corrects for it.*



Correcting for Water Vapor Pressure

- *In order to correct for the water vapor pressure in our calibration gases, we need to make water vapor pressure a known value (or a constant) when we calibrate the analyzer.*
 - *The calibration gases are saturated with water vapor by running them through a humidifier prior to the gases being measured.*
 - *Water saturated gas has a water vapor pressure of 47 mmHg (at 37°C).*
 - *If our water vapor saturated gas produces a total pressure of 760 mmHg, then a dry gas would have a pressure of $760 - 47 = 713$ mmHg.*

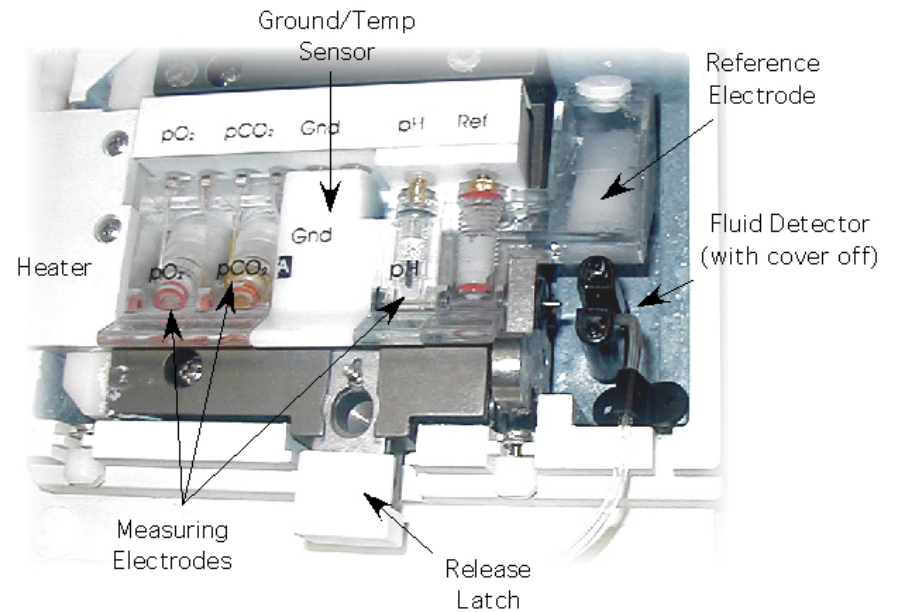


Blood Gas Analyzer Components

- All blood gas analyzers have the following components:
 - Electrode Module
 - Reagent module
 - Humidifier Wells
 - Sample Input Port
 - Peristaltic Pump
 - Waste Module

Electrode Module

- pH Electrode
 - Output varies with the pH level of the sample being analyzed.
- pCO₂ Electrode
 - Produces a voltage proportional to the pCO₂ content of the sample.
- pO₂ Electrode
 - Produces a voltage proportional to the pO₂ content of the sample.
- Reference Electrode
 - Supplies a constant, unchanging electrical potential (756 mV) that is used as a reference to measure the electrical potential produced by each measuring electrode.



Electrode Module

Heater

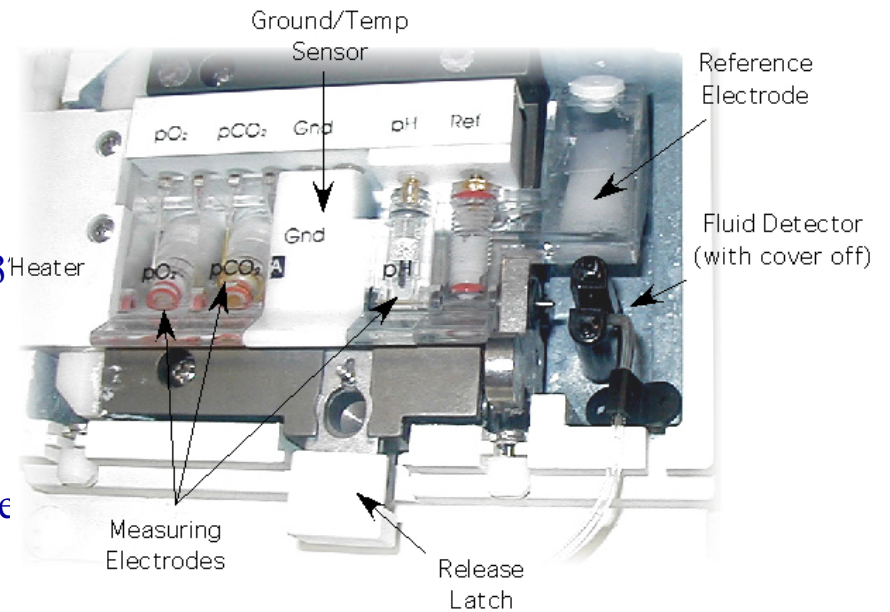
- Maintains the electrode module at 37°C.

Temperature Sensor

- Monitors the temperature of the Electrode Module and indicates when the temperature is more than 2 degrees below (or above) 37°C.

Air/Fluid Detector

- Located at the entrance or exit of the Electrode Module.
- Verifies the presence of air or fluid in the sample tubing.
 - A small light source shines through the tubing into a photodetector.
 - The photodetector is monitored by the μP which monitors the air/fluid detector so it knows when to start and stop the peristaltic pump.





Blood Gas Analyzer Components

- The reagent module houses the two solutions used to calibrate the pH electrode and the wash solution.
 - There are two liquid solutions used to calibrate the pH electrode during a 2 point calibration (more on 2 pt calibrations later).
 - The Cal solution has a pH level of 7.382
 - The Slope solution has a pH level of 6.838
 - The Wash solution is used to wash the patient sample out of the analyzer after analysis.
- The humidifier wells are used to saturate the gases used to calibrate the pO₂ and pCO₂ electrodes with water for the reason we talked about earlier.
 - As the calibration gases (Cal gas and slope gas for 2 point calibration) enter the analyzer from their pressurized tanks, the first component they come to is the humidifier well.
 - The humidifier well is a well with humidifier solution in it (deionized water) that the gas bubbles through on it's way to the electrode module for measurement by the pO₂ and pCO₂ electrodes.



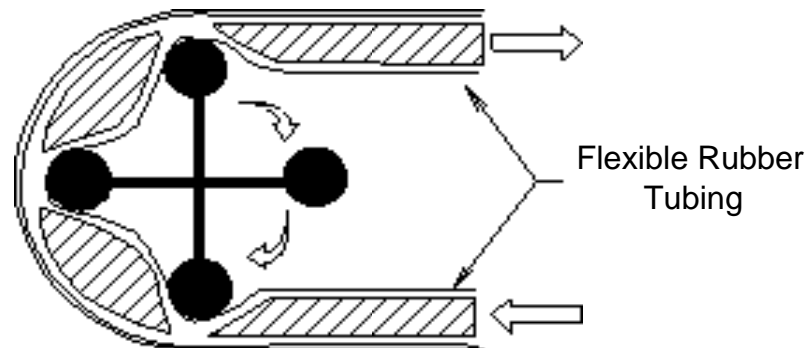
Blood Gas Analyzer Components

- The Sample Input Port is where the patient sample is entered into the analyzer.
 - The patient sample is usually entered into the analyzer using the same syringe that was used to draw the blood sample with.

Blood Gas Analyzer Components

Peristaltic Pump

- Pushes the reagent fluids and patient sample through the tubing to the Electrode Module out to the waste bottle.
- Fluid is drawn into the analyzer as the flexible tubing is pressed by the rollers of the pump and drawn through the tubing via the squeezing action of the rollers on the tubing.
- Peristaltic Action





Blood Gas Analyzer Components

- The Waste Module is the container that collects the patient sample after analysis.
 - It has to be properly collected and disposed of; it has blood in it so it can't just be sent down the drain.
 - It has to end up with the bio-hazardous waste.



2 pt cal

- Now, instead of the two values for Sodium, as I used in my 2 pt cal example, the blood gas analyzer would be using the 2 liquid reagents in the reagent module to run a 2 pt cal on the pH electrode (remember, the pH of the two solutions was 7.3 and 6.8), and 2 calibration gases (cal gas and slope gas) to run a 2 pt cal on the pO₂ and pCO₂ electrodes.
 - The cal gas has 12% oxygen and 5% CO₂, the remainder is nitrogen gas.
 - The slope gas has 0% oxygen and 10% CO₂, the remainder being nitrogen gas.

