Intoxilyzer 9000

Infrared Theory

According to a principle in physics called Planck's Law, all matter will emit electromagnetic radiation above absolute zero. One type of electromagnetic radiation emitted, is Infrared light energy. This type of light energy contains both electric and magnetic properties. It falls on the light spectrum between the visible light region and the microwave region. Unlike "visible" light, however, infrared (IR) light cannot be seen with the naked eye.

When infrared light passes through a concentration of molecules, the molecules will consistently and uniquely absorb the infrared light at particular wavelengths, creating what can be considered a "molecular fingerprint".

A portion of the ethanol absorption pattern of infrared light by ethanol appears in the 9 μm (micrometer) region of Infrared. The Intoxilyzer 9000 uses this region of IR absorption to specifically and consistently detect ethanol in a breath sample. If there is anything present in a sample that is not ethanol but absorbs infrared light in the same region as ethanol, the Intoxilyzer 9000 will flag it as an interferent and no numerical results are given.

HENRY'S LAW

Henry's Law is important to understand for breath alcohol analysis because it describes why breath testing works as an analytical technique. Henry's Law states that in a closed system, at any given temperature and pressure, at equilibirium, the concentration of a volatile substance in the air above a fluid is proportional to the concentration of the volatile substance in the fluid.

This relates to the human body when ethanol is present in an individual's bloodstream and is brought into contact with air in the lungs (closed air space). Within the lungs there is constant temperature and pressure which allows for an equilibrium to be rapidly formed between the ethanol in the blood and ethanol in the air. The equilibrium has a ratio associated with it. The ratio of 2100:1 exists between the concentration of ethanol in the deep lung air and the concentration in the blood. This ratio is specific for 37°C, average body temperature. This means that 2100 milliliters of alveolar or deep lung air will contain the same weight of alcohol as does 1 milliliter of pulmonary arterial blood. The breath testing instrument uses this ratio to calculate a blood alcohol concentration level (BAC) from a breath alcohol sample.

Analytical Bench and Components

The region of the Intoxilyzer 9000 where analysis of samples takes place is referred to as the **Analytical Bench**. Here, samples are analyzed using ***Infrared energy*** which is the basis of infrared theory. Using known wavelengths of infrared energy, the Intoxilyzer 9000 is designed to specifically analyze for ***ethanol in a sample***.

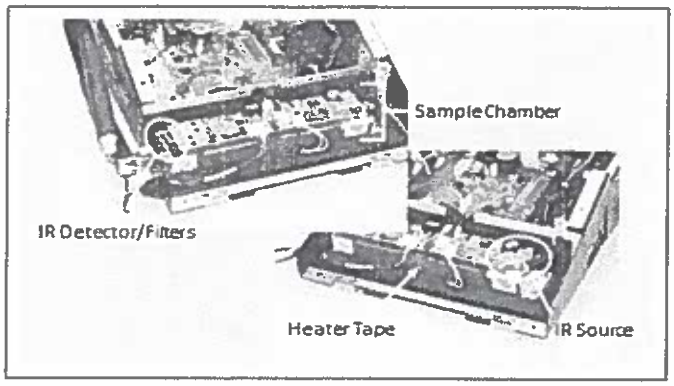

Figure 1

SOURCE - The infrared source, or IR source, used in the Intoxilyzer 9000 is a pulsed led source which allows for the sample to be analyzed at a rate of 20 times per second.

SAMPLE CHAMBER - Is where a sample passes through as it is being analyzed. The sample chamber is also where the flow sensor is located. The flow sensor allows the instrument to measure the volume and pressure of a breath sample entering the instrument over a period of time.

HEATER – encapsulates the analytical bench and heats it to a constant temperature of ***47°C ± 0.2°C.***

FILTER - The specificity of ethanol for the Intoxilyzer 9000 is accomplished by having specific infrared filters. Each filter will allow only one specific wavelength of infrared energy through to its dedicated detector.

DETECTOR - When the IR light/energy strikes the detector, the detector will heat up, creating a voltage. There is a direct relationship between the increase in heat and the voltage. The greater the increase in heat, the higher the voltage generated. The opposite is true with less heat creating less voltage. The instrument measures the voltage generated by each detector and will use this measurement in the calculation of the blood alcohol concentration (BAC).

Measurement of a Breath Sample

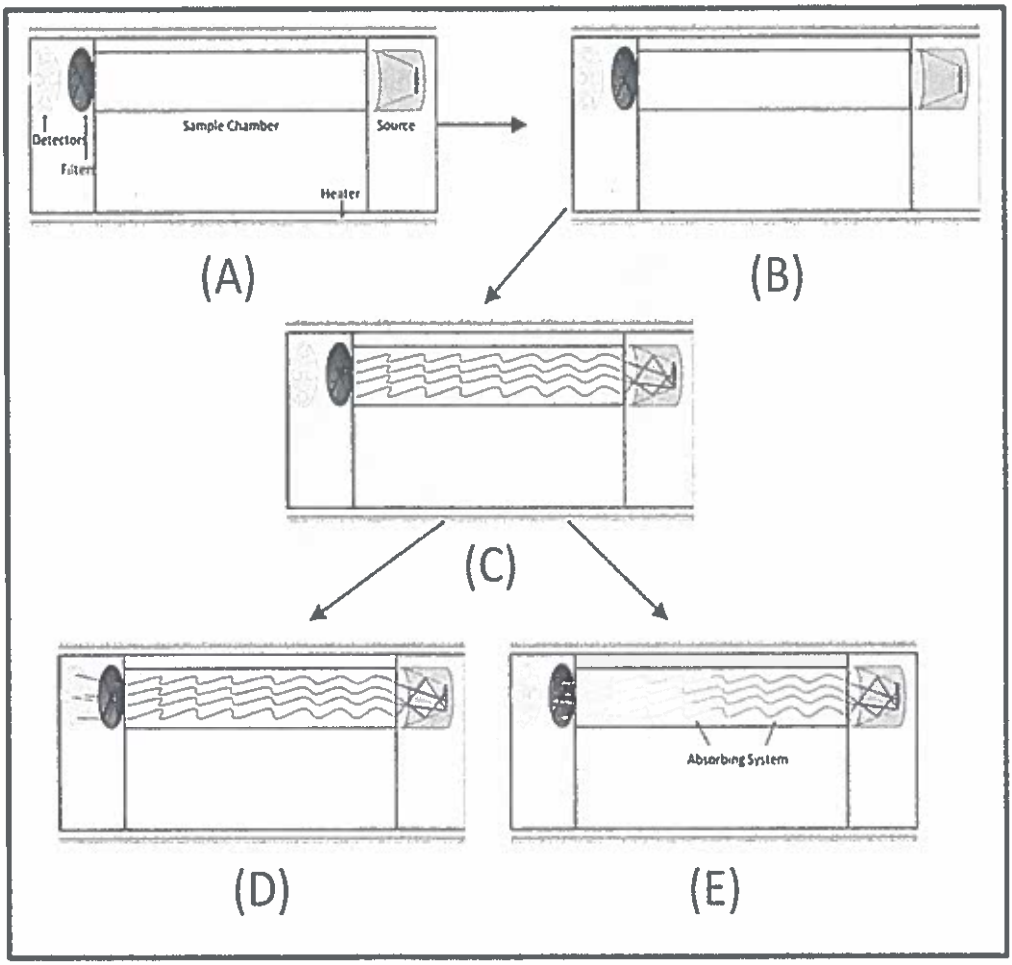

Figure 2

We can put together the five main components as depicted in Figure 2, to explain how the analytical bench functions and obtains a measurement:

A. Shows the five components of the analytical bench
B. The first component, the source, heats up. The heating up of the source produces and emits infrared energy (or heat energy).
C. This energy is focused into the sample chamber. The energy will travel through the heated sample chamber which is kept at a constant temperature by the heater. The infrared energy will then strike the filters, allowing only light of four specific wavelengths to pass through.

D. The filtered wavelengths will strike the respective photodetectors. The energy striking the detector will create a voltage.

E. When there is an absorbing system in the sample chamber, for example ethanol, the infrared energy will interact with it. The greater the amount of ethanol present in the chamber, the more IR energy will interact and the greater the absorption, the less energy will strike the detector. The less energy that strikes, the lower the voltage generated.

Three types of samples the Intoxilyzer 9000 analyzes during the course of a breath test include:

- ambient air samples ("air blank")
- breath samples
- ethyl alcohol standard samples ("calibration check" or "cal check")

During the sequence of a test "WADACABA" (Discussed Below), an air blank will always occur first. The instrument will purge the sample pathway and take a measurement of the room's ambient air; the reading should be .000%. This indicates that no infrared energy was absorbed, as demonstrated by letter (D in Figure 2). This will be used as a baseline to measure samples.

During the testing of a breath sample or a calibration check, if ethanol is present, there will be absorbance of infrared energy as depicted in (E in Figure 2). The amount of energy absorbed by the ethanol sample is calculated by the difference between the baseline energy and the energy measured when the sample is present in the sample chamber. (See Figure 3 below)

To find out how much light energy was absorbed:

$X^1_{\text{(Initial measurement or 100\%)}} - Y^1_{\text{(Final measurement)}} = \text{Light Absorbed}$

X^1 – is the initial measurement of light, it can be thought of as 100% light transmittance (Air Blank)

Y^1 - is the final measurement of how much light that **HAS NOT** been absorbed (Occurs During Calibration Check/Breath Test)

Figure 3

Instrument's sequence WADACABA.

a. Wait
    1) The "Wait" period is to ensure that the subject has been observed for at least 20 minutes prior to the breath test, ensuring there is no mouth alcohol.

b. Air blank
    1) During the "Air Blank" the Intoxilyzer 9000 is purging itself by drawing ambient air in from the room which it is located at, through the breath tube and the sample chamber and exits throught the exhaust. At the same time, the instrument is analyzing the ambient room air as it passes through the instrument ensuring that there is nothing in the room's air which may prevent the instrument from zeroing itself out, eliminating the possibility of any results getting skewed.
    2) A base line (starting point) of the amount of infrared energy is determined from the results of the air blank .

c. Diagnostic check
    1) Is a series of tests the instrument runs to ensure that it is in proper working condition.

d. Air blank
    1) Same as explained in previous airblank defined in step b.

e. Calibration check
    1) The instrument's operability is confirmed by analyzing a solution with a known amount of ethanol or ethyl alcohol.

f. Air blank
    1) Following the Cal Check where ethanol was introduced into the Intoxilyzer 9000 this airblank is performing the same functions as the previous airblank defined in step b.

g. Breath test
    1) The instrument will indicate that it is ready to analyze a breath sample by illustrating the words **"PLEASE BLOW"** on the display. As the subject is blowing into the instrument, an audible tone will be emitted indicating that it is receiving a sample.

h. Air blank

1) Following the Breath Test where ethanol may have been introduced into the Intoxilyzer 9000, this airblank is performing the same functions as the previous airblank defined in step b.

Exception Messages

"Ambient Fail"

The instrument was not able to clear the sample chamber prior to the diagnostic.

"Purge Fail"

The instrument was not able to clear the sample chamber out during any air blank after the diagnostics.

"Subject Refused"

This message is activated by a breath alcohol technician when a subject refuses to give a breath sample. The printout generated will have "Subject Refused".

"No Sample Given"

There is a 3 minute window to obtain a sample. If no sample is given, the instrument will end the test and print "No Sample Given."

"Insufficient Sample"

If the subject does not provide a sufficient sample after 3 minutes the test will end and the print out will read "Insufficient Sample."

"Invalid Sample"

The instrument measured a sharp increase and decrease within a sample. This is indicative of mouth alcohol.

"RFI Detected"

The instrument detected a spike in radio frequencies and aborted the test.

"Interferent Detected" during a Subject Test

The instrument detected something in the breath sample that is not ethanol and aborted the test.

"Sequence Aborted"

The "Abort" button was pressed twice during the breath test.

"Range Exceeded"

The amount of alcohol measured was greater than 0.650.

"Improper Sample"

The subject attempted to provide a sample at the wrong time, outside the 3 minute sampling window. No result given.

"Interferent Detected" during a Calibration Check

The instrument detected something during the calibration check that is not ethanol and aborted the test.

"Calibration Out of Tolerance"

The calibration check is outside of the acceptable range of 0.100% ± 0.01% (0.09%-0.11%).

"Diagnostic Fail"

A diagnostic test fails.

Standards

Calibration Check: As per NYS Codes, Rules and Regulations, Part 59.5 (d), the reference standard value must agree within the limits of plus or minus 0.01% or such limits as set by the commissioner of the Department of Health. Therefore,

Standard Target value: 0.100% (0.110% to 0.090%)