Evaluation of an Ethanol Blood Diffusion Model Apparatus

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Abstract & Background

In the State of Connecticut, and many other states using breath testing as part of DUI case investigation, two breath tests are administered some minutes apart (generally ~ 20). Testing is not commonly performed at the scene of arrest, rather breath testing instruments are maintained at police or troop headquarters. Breath testing may then be performed some significant time after the time of driving.

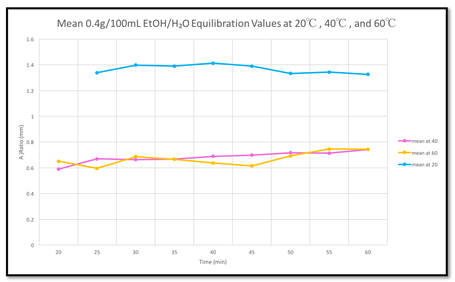
The differences in the test results are used to determine the rate of elimination of alcohol in the subject at the time of the test. That information may then be used to "back extrapolate" from the time someone is accused of driving under the influence of alcohol. Depending on the results, inferences may also be drawn as to whether or not alcohol is still being absorbed and distributed around the body of the test subject.

The image below shows an example alcohol concentration curve v. breath flow curve. [EtOH] continues to rise throughout the test, albeit at a slower rate after "lung only" air has reached the instrument measurement cell. Because the two tests are not corrected to blow volume, the second test may be artifactually low or high compared to test 1, if the blow volume is not "corrected." The purpose of this research is to ultimately determine the extent to which the slope in the latter part of the breath v. [EtOH] curve can be described by a linear equation, and further, the extent to which that slope is a function of individual variation. The ultimate question is to determine if breath alcohol test results can be corrected for volume variations.

The first part of exploration of the these questions involved development of a diffusion-based model that could be utilized to evaluate the linearity of the diffusion-based rise in [EtOH] after un-equilibrated air was removed from the system.

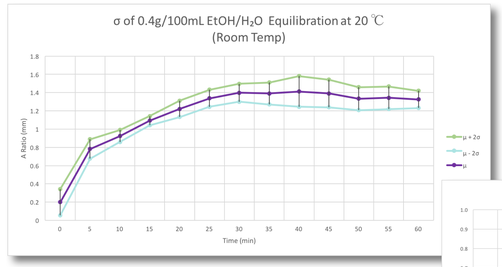
Objectives

The objective for this project was to first find an ethanol blood diffusion model apparatus and then test and evaluate the curve of the graphs produced to see how well they could be expressed linearly.



Materials and Methods

Two solutions were prepared; 0.2g/100mL n-propanol/H_2O and 0.4g/100mL EtOH/H_2O. A 500mL glass container containing 25mL of the n-propanol solution was kept at either 20℃, 40℃, or 60℃ during the experiment. After the system was allowed to come to equilibrium with the air and the n-propanol, strips of dialysis tubing (approximately 8 inches long) were filled with 10mL of the EtOH solutions and suspended in the glass container (see Image B). Immediately after the dialysis tubing was added to the system the first sample of air was extracted (Time=0 min) with a syringe through the top of the cap. Samples were consistent of 50 or 80uL of air, taken in 5 minute intervals over the course of an hour. The samples were then injected immediately into the Flame Ionizations detector (FID) (see Image A). The FID would then run the sample for 3.5 minutes and then produce a graph that was analyzed and measured to see how much ethanol was diffused into the air inside the system. Three runs were conducted at each temperature (20℃, 40℃, and 60℃) and graphs were created to show the diffusion of ethanol over time. Finally the mean of those three runs and the standard deviation of the mean were calculated and analyzed.



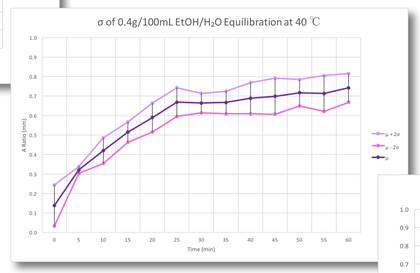
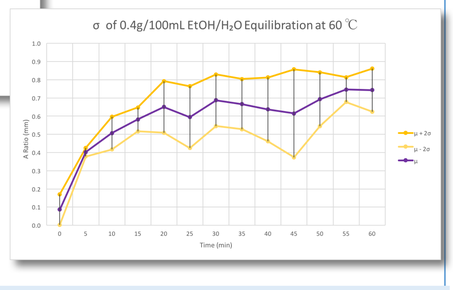


Image B



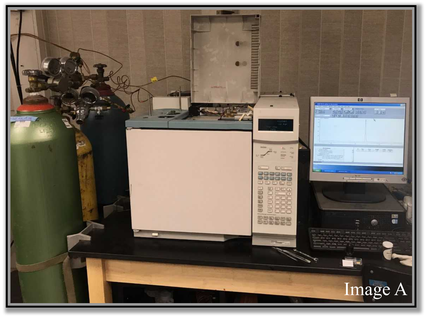


Image A

Results and Discussion

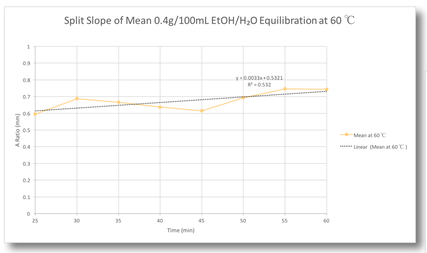
These are the standard deviation values (σ) when a linear line is applied after the peak of each mean line of 0.4g/100mL EtOH/H_2O at 60℃, 40 ℃, and 20 ℃.

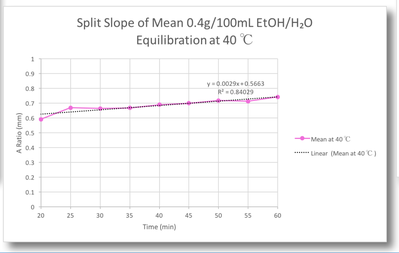
(0.4g/100mL EtOH/H_2O) 60℃ σ = 0.532

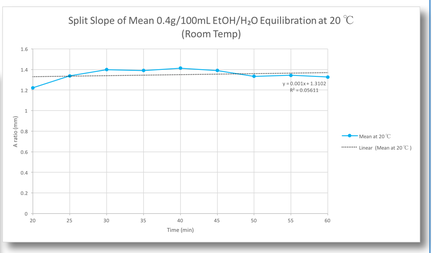
(0.4g/100mL EtOH/H_2O) 40 ℃ σ = 0.949

(0.4g/100mL EtOH/H_2O) 20 ℃ σ = 0.748

All of the standard deviations produced are considered significant. Many of the abnormalities can be explained through the following sources of error; the system's temperature could have been inconsistent throughout each run for a particular temperature, and the headspace pressure would have increased throughout the diffusion process causing less of the ethanol to diffusion, therefore hindering the results. The large margin for standard deviation for the 0.4g/100mL EtOH/H_2O at 60℃ can be explained by the Flame Ionization Detector beginning to malfunction towards the end of the project causing some abnormal readings during the experiment. Tests done under 40 ℃ and 20 ℃ were more consistent with temperature control for each of the three runs conducted to produce the mean slope line. The runs for each temperature were attempted to be conducted on the same day to avoid variation in the detector from day to day malfunctions. More data would be needed to be collected to achieve any further results about this experiment







Conclusion

It is possible that ethanol blood diffusion graphs could be explained linearly. Though this ethanol blood diffusion apparatus model is not an extremely accurate representation of the way alcohol equilibrates with the blood and the air in the lungs, it does show the possibility that ethanol blood diffusion graphs can be explained linearly. The use of the Flame Ionization Detector worked well in detecting the amount of EtOH diffused into the headspace and would work well in future work.

Future Work

The use of the Flame Ionization Detector worked well in detecting the amount of EtOH diffused into the headspace. The test should be done in smaller intervals of time to minimize large amounts of variation between samples. Keeping the air inside the system moving or swirling would also be advantageous to ensure every sample is taken while the air inside the system is at equilibrium.

References

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