PERFORMANCE EVALUATION OF AN EXPERIMENTAL SYSTEM MEASURING ETHANOL CONCENTRATION

Erinda Piluri552
Hasime Manaj553
Ilirjan Malollari554
Irakli Premti555

DOI: https://doi.org/10.31410/eraz.2018.862

Abstract: In this set of experiments we measure a soluble gas, ethanol in a non-invasive technique using a continuous system. The analogy of this system with our lungs is the main motivation behind the experiments conducted. In our first set up we use three continuous isolated vessels, with equal amount of solution water-ethanol, with ethanol concentration 0.476 mg/l. The connectors used between vessels, for each set of experiments, are of specific diameter as it influences the pressure drop in our system. Air passes through each vessels solution with a fine-gas sparger and carries with it a certain amount of ethanol vapor which, when it evaporates, lives in the upper part of the solution. This process is repeated in the second vessel where the air from the first reactor is passed to the second vessel and again absorbs an amount of ethanol vapor and passed to the third vessel where, unlike the first two, we try to achieve equilibrium between the concentration alcohol content and concentration of alcohol in the air. The air stream after leaving the third reactor is passed to the analyzer for mass concentration of alcohol. We conducted a second run of experiments, in the same conditions but with four vessels in series. Gas flow was kept 12 L/min and temperature ranged from 32°C to 38°C. Through comparison of ethanol concentration outside of the system we evaluated the efficiency of each system, concluding that the second system has a better performance.

Key words: Ethanol concentration, continuous system, temperature and pressure parameters

1. INTRODUCTION

In this set of experiments we measure a soluble gas, ethanol in a non-invasive technique using a continuous system. After drinking, the alcohol diffuses through the stomach and the small intestine wall, passing via the capillaries into the bloodstream. It is well known that on the one hand alcohol is a stimulant but on the other hand, from a medical point of view, it is a cellular toxin.

The analogy of this system with our lungs is the main motivation behind the experiments conducted. In our first set up we use three continuous isolated vessels, with equal amount of solution water-ethanol, with ethanol concentration 0.476 mg/l. The connectors used between vessels, for each set of experiments, are of specific diameter as it influences the pressure drop in our system.

552 General Directorate of Metrology, Highway TR-DR, Km 8, Kashar, Tirane, Albania
553 Faculty of Natural Sciences, University of Tirana, Boulevard Zogu I, Tirane
554 Faculty of Natural Sciences, University of Tirana, Boulevard Zogu I, Tirane
555 Polytechnic University of Tirana, Square Mother Tereza, Tirane
2. EXPERIMENTAL MEASUREMENTS OF TEMPERATURE

Due to the volatile nature of ethanol, a certain quantity of alcohol, proportionate to the blood alcohol concentration, transfers from the blood to the lung alveoli (in the same way that CO2 moves from the blood to the lung alveoli) in order to be eliminated, as illustrated in Figures 1. Based on this phenomenon, it is possible to measure the alcohol concentration from a deep exhaled breath sample with high accuracy, according to Henry’s law. In this set of experiments we measure a soluble gas, ethanol in a non-invasive technique using a continuous system. The analogy of this system with our lungs is the main motivation behind the experiments conducted.

Figure 1: Lung alveoli

In our experimental system measuring ethanol concentration, the air flows through three vessels which are connected in series. Each vessel contains a Ethanol/Water solution with well-known concentration. All vessels are located in a thermal bath to realize a defined temperature of e.g. 34 °C. Usually the following parameters are varied to obtain different ethanol concentrations in the gas stream:

- temperature of the bath, T= 34 °C
- concentration of Ethanol in the Ethanol/Water solution, 0.476 mg/L
- gas flow of the gas (usually between 1 Liter/minute and 20 Liters/minute
- kind of gas flowing through the apparatus (air or nitrogen)
- pressure at the outlet of the system.

These parameters are very important for the establishment of equilibrium of a certain ethanol concentration in the gas stream.

3. RESULTS AND DISCUSSIONS

We conducted the set of experiments with three vessels is series. Gas flow was kept from 8 to 24 L/min and temperature 34 °C. After receiving all the values from the experiments we had these results.
We conducted a second run of experiments, in the same conditions but with four vessels in series. Gas flow was kept 12 L/min and temperature range 34 °C. After receiving all the values from the experiments, we compared the values and we have the results in the graphs below.

![Graph showing flow dependency from concentration](image1)

**Figure 1:** Graphic presentation of flow dependency from concentration

\[ V=500 \text{ ml}, T = 34°C \]

\[ y = -0.0009x + 0.399 \]

\[ y = -0.0009x + 0.3871 \]

![Graph showing number of measurements dependency from concentration and temperature](image2)

**Figure 2:** Graphic presentation of number of measurement dependency from concentration and temperature

\[ V=500 \text{ ml}, T = 34°C, \text{three vessels} \]
4. CONCLUSIONS

At the end we arrived in these conclusions:

- The increase of temperature brings a linear increase of the concentration of ethanol in the gas phase with a fixed ratio of ethanol in gas separation within solution.
- The increase speed of flow of the gas flow decreases the concentration of ethanol in the gas phase.
- By using at least three or four vessel in series, a stable value of mass concentration at exit is achieved, allowing a fairly large number of measurements to be made.
- Through comparison of ethanol concentration outside of the system we evaluated the efficiency of each system, concluding that the second system has a better performance.

REFERENCES


PhD. Irakli Premti is part of the staff working at Polytechnic University of Tirana, Department of Mechanics of Structures. FIN is one of the oldest and most experienced faculties in Albanian higher education.