First Line of the Title
Second Line of the Title

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Course: Or other indication
Academic Year: Or some time indication

ABSTRACT

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Key-words: Key, Words, Here

NOMENCLATURE

Type A

x	X quantity

Type B & Misc

y	Y quantity

CONTENTS

1 INTRODUCTION

1.1 Context

1.2 Objectives

We have to determine the breakthrough curve of a knwon step injection of a tracer substance in a column of porous medium. The tracer is a non-reactive solute, and the column is saturated with water. The experiment will help us understand the transport properties of the porous medium.

2 THEORETICAL BACKGROUND

2.1 Relevant Equations and Models

Trasmittance index:

$$T = \frac{I}{I_0} = 10^{-eCL} \tag{1}$$

where:

- T is the transmittance index
- I is the intensity of the light passing through the solution
- I_0 is the intensity of the light passing through a reference sample (clean water)
- e is the absorption coefficient of the solute
- C is the concentration of the solute in the solution
- L is the length of the optical path through which light passes in the solution
- C is the concentration of the solute in the solution

We can then determine the absorbance

$$A = \log_{10}\left(\frac{1}{T}\right) = eCL \tag{2}$$

In practice the Reference sample is associated to an absorbance of $A = 1$, by observing the difference in ight intensity, knowing the optical path, we can determine the relative concentration of the flowing solution:

$$\frac{A}{A_{ref}} = \frac{C\cancel{e}\cancel{L}}{C_{ref}\cancel{e}\cancel{L}} = \frac{C}{C_{ref}} \tag{3}$$

3 EXPERIMENTAL SETUP

3.1 Materials and Instruments

The experimental setup consists of a small column designed for didactic purposes, ensuring the experiment can be completed in a reasonable time. The column is 19.5 cm high and 1 cm in diameter, filled with spherical quartz of known porosity. Water flows through the system using a XXX pump, with the desired flow rate set directly on the pump. However, the actual flow rate is reduced by the resistance of the pipes and the porous medium. To determine the real flow rate, a scale is used to measure the water collected in a beaker placed at the spectrophotometer's exit.

After exiting the column, the water flow passes through a spectrophotometer that measures its transmittance. This value is then compared to the transmittance of a reference sample of clean water to obtain a relative measurement. The flow is regulated by three valves, ensuring a continuous flow of either clean water or water mixed with a tracer, with only one substance passing through the column at a time. For this experiment, a non-reactive tracer is used, specifically a solution of NaNO3 in water.

The entire experimental setup and data gathering process is controlled using LabVIEW on a computer. The spectrophotometer and the scale are connected through serial interfaces, and the system is configured to take readings every second.

3.2 Procedure

The procedure is programmed to run automatically using LabVIEW. The experiment begins by flowing water through the system for a specified duration of X minutes. Following this initial phase, a tracer solution is injected into the flow for 480 seconds. After the tracer injection, the flow is switched back to water, and the cycle is set to repeat. However, only one complete cycle needs to be observed for this experiment.

During the experiment, the relative transmittance of the flowing solution is continuously monitored and compared to that of clean water. Additionally, the absorbance is calculated using the Lambert-Beer law within the software.

3.3 Preliminary Evaluation

To initiate the experiment, we needed to establish a flow rate that would allow us to observe the profile within a reasonable time frame. We estimated the breakthrough time of the profile using the pore velocity vpvp, which can be calculated as:

$$v_p = \frac{Q}{An} \tag{4}$$

where:

- v_p is the pore velocity in m/s
- Q is the unknown flow rate of the water in m3/s
- A is the known cross-sectional area of the column in m2

- n is the porosity of the medium (dimensionless)

The porosity n can be determined using the mass of water in the column:

$$n = \frac{V_w}{V_{\text{total}}} = \frac{m_w/\rho_w}{V_{\text{total}}} = \frac{m_w}{\rho_w V_{\text{total}}} \tag{5}$$

We selected a desired pore velocity v_p such that the breakthrough would pass through the column (ignoring the pipes) in 5 minutes:

$$v_p = \frac{L}{t} = \frac{0.195}{300} = 0.00065, \text{m/s} \tag{6}$$

Using this pore velocity, we computed the required flow rate Q:

$$Q = v_p A n = 0.00065 \cdot \pi \cdot (0.01)^2 \cdot n = 0.00065 \cdot \pi \cdot (0.01)^2 \cdot 0.4 = 8.16 \times 10^{-6}, \text{m}^3/\text{s} \tag{7}$$

This is the actual flow rate we aimed to achieve. To account for the resistance of the system, we set a higher flow rate on the pump, settling for $2.002mL/min$.

4 RESULTS

4.1 Data Collection

We obtained a tabe with the reading istant by instant.

4.2 Data Processing

5 DISCUSSION

5.1 Interpretation of Results

5.2 Sources of Error

6 CONCLUSION