UNIVERSITY OF MICHIGAN
Department of Mechanical Engineering
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Van Slyke Apparatus - Analysis of Theory and Operation

(partial fulfillment of M.E. 490)

by

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VAN SLYKE ANALYSIS

INTRODUCTION

Currently the University of Michigan Multi-phase Flow Laboratory is conducting research into the spectral distribution of cavitation noise. Water is used as the working medium and cavitation noise is measured in a plexiglass venturi test section. Air dissolved in water has significant effects on cavitation intensities. Therefore an accurate means of measuring air content in the water being used was deemed necessary. A Van Slyke apparatus was available and the purpose of this report is to explain the operating procedure and theory behind its operation.

THEORY

By reducing the pressure of a sample of water to nearly 0 PSIA the dissolved air can be taken out of solution and measured using the ideal gas laws. The Van Slyke apparatus uses these principles for measuring the air content of water samples. By using a series of valves and a movable mercury reservoir water samples can be drawn into the apparatus and subjected to either vacuum or pressure. A column of mercury is attached to the apparatus which indicates the pressure in the system (calibrated in millimeters of mercury). The operation begins with the admission of a 10 cc sample into a calibrated volume. Next the sample is exposed to a very high vacuum and agitated. After a sufficient period of time the seperated gas and sample are returned to a 11 cc calibrated volume. The sample still occupies 10cc therefore the gas must occupy 1 cc. The calibrated column indicates the pressure that the removed gas exerts on the system. Since the volume, pressure, and temperature of the sample are known the mass can be easily obtained by the ideal gas law; PV=mRT. Since the standard means of specifying gas content is by volume percent, it isn't necessary to calculate the mass. Instead the 1 cc volume is corrected to standard temperature and pressure and the corrected volume is used for calculating the volume percent of air contained in the sample. The pertinent equations used for calculating the air content are presented below.

Volume correction to STP.

$$\frac{P_1 V_1}{T_1} = \frac{P_{STP} V_2}{T_{STP}}$$

$$V_2 = 1\text{cc} \times \frac{\Delta h(\text{mmHg})}{760(\text{mmHg})} \times \frac{273^\circ\text{K}}{T\ (^\circ\text{K})}$$

Volume percent of air in sample.

$$\%\ \text{Air} = \frac{V_2}{10\ \text{cc}} \times 100$$

The combined relation in simplified form is:

$$\%\ \text{Air} = 3.5921\ \frac{\Delta h(\text{mmHg})}{T(^\circ\text{K})}$$

PROCEDURE

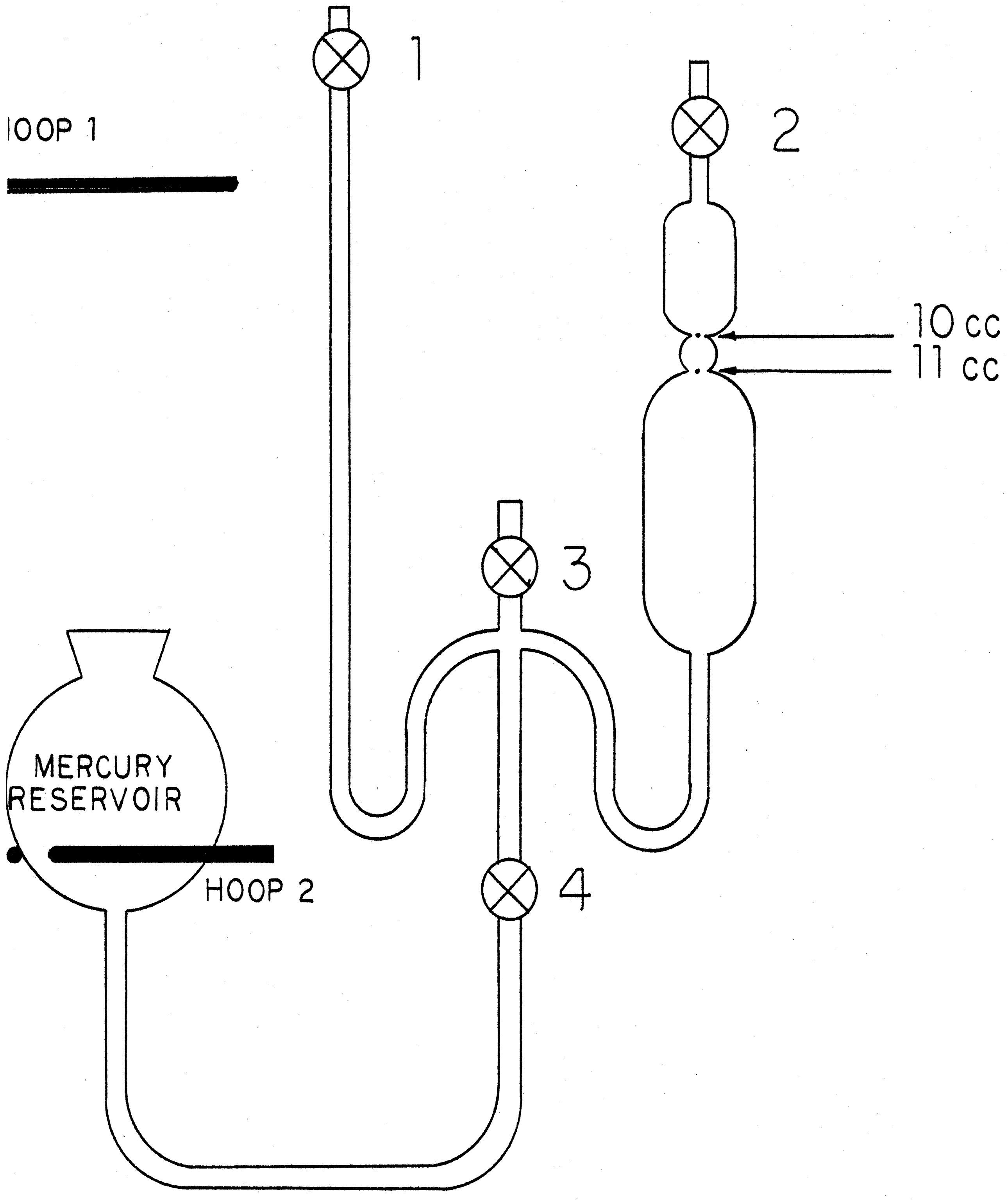
1. Open valves 1 and 4 and hold the reservoir even with the top of the Van Slyke apparatus allowing the mercury to completely fill the calibrated column. Close valve 1 and return the reservoir to the top ring. (Note: This step is only required once and shouldn't have to be repeated before each measurement.)

2. Open valve 2 and use valve 4 to raise the level of the mercury to the base of valve 2.

3. Place the mercury reservoir on the middle hoop. Open valve 2 and draw the sample into the test section using valve 4. When the mercury level reaches the first calibration mark, exactly 10cc of water have been drawn into the system.

4. Close valve 2, open valve 4, and place the reservoir on the lowest hoop. Agitate the sample for about 5 minutes. Close valve 4. Note the position of the mercury column.

5. Return the reservoir to the top ring. Using valve 4 bring the mercury level to the second calibration mark. Now the gas and water are contained in exactly 11cc. Read the level of the mercury column and the difference is the pressure exerted by 1cc of gas. Using the combined relation from the first page the volume percent of dissolved air can be calculated.



OOP 3

VAN SLYKE DEVICE