

Fig. 3-1 Structural formula of rhodamine B (Reference ?).

### 3.2. Experimental Setup

A schematic representation of the pilot scale water treatment system is shown in Fig. 3-2. The treatment system consists of two loops: the inner and outer loops. The inner loop has the tank (Tank 1; volume, dimensions?), a diaphragm pump (SHURflo Model 8000-533-236), a heat exchanger, and a pressure relief valve (model, make, city, state?). The outer loop is comprised of the tank (Tank 2; volume, dimensions?), the pump, heat exchanger, and pressure relief valve, and cavitation device. The loop can be switched from the inner loop to the outer loop (or vice versa) using a three-way valve (Valve 2; model, make, city, state?). The heat exchanger is connected to a chiller (NesLab CFT-33), which allows the treatment system to maintain a constant temperature. A pressure gauge (model, make, city, state?) is located between the cavitation device and the three-way valve (Valve 2). The inlet pressure of the

cavitation device can be adjusted using the pressure relief valve located between the pressure gauge and the heat exchanger.

The cavitation devices tested include Venturi tubes (Mazzei Injector Company, LLC, CA), orifice plates, and needle tubes. The schematic of various cavitation devices used in this study is shown in Fig. 3-3. The Venturi tubes were purchased from Mazzei Injector Company, LLC, CA. The single- and multiple-hole orifice plates were manufactured using a US dime. Various types of the needle tube were manufactured by inserting a needle into an orifice's hole. The needles were obtained from Cadence, Inc., VA.

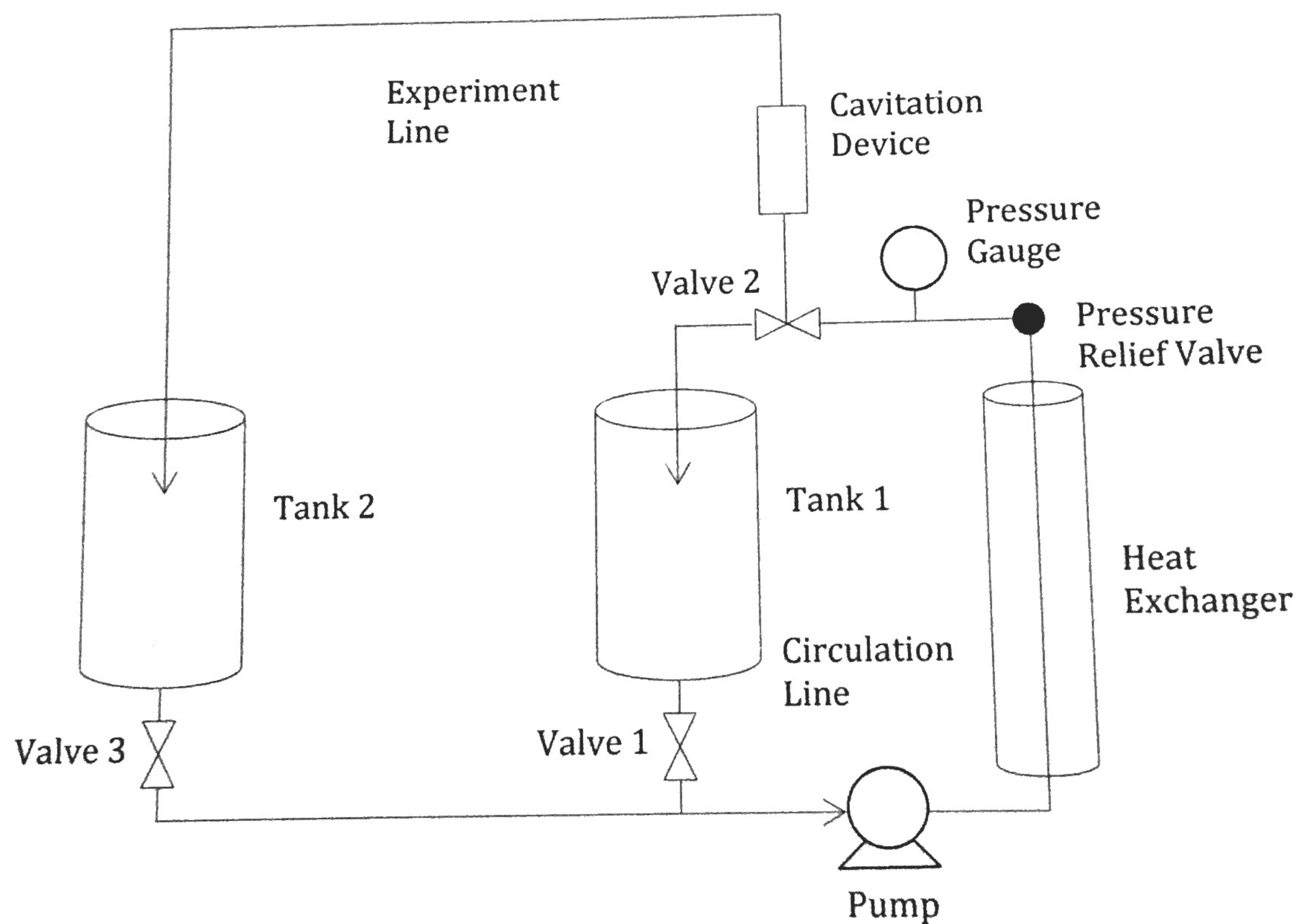


Fig. 3-2 Schematic Representation of The Hydrodynamic Cavitation System.

and 1.20 x 10<sup>5</sup> g/L (give molar concentration).

#### 4. Analysis

A water sample was analyzed for the concentration of dye and pH immediately after the sample was collected. The concentration of rhodamine B dye was analyzed with UV-vis spectrophotometer (Hewlett Packard 8452A Diode Array Spectrophotometer, City, State ?) at 554 nm wavelength (Sivakumar and Pandit, 2001; 2002). pH of the solution was measured by a pH meter (Thermo Scientific Orion™ Star A121).

Temperature of the solution was measured in the Tank 1 (in the initial stage) and Tank 2 (in the cavitation stage) with a thermal sensor (model, make, city, state?).

## Appendix-A: UV-vis-spectrophotometer Calibration

### A. Preparation of Rhodamine B Standard Solutions

Standard solutions were made from diluting rhodamine B stock solution with DI water. Standard solutions for the high initial concentration experiments and the low initial concentration experiments were made at different time according to the following procedures.

#### 1. Standard Solution for Low Initial Concentration Experiments

- A 1.00 g/L stock solution was obtained with dissolving 0.10 g reagent grade rhodamine B into 100 ml DI water. 1 ml stock solution was then diluted into 100ml solution with a concentration of  $1.00 \times 10^{-2}$  g/L (Dilution I).
- The concentrations of rhodamine B standard solution and the volume ratios of the Dilution I solution to DI water are summarized in Table A-1.

Table A-1. Rhodamine B Standard Solution for Low Initial Concentration Experiment

Standard ID	mL of Dilution I Solution Diluted to 50 ml with DI Water	Total Volume, ml	Concentration of Rhodamine B Standards, mg/L	Concentration of Rhodamine B Standards, mmol/L
1	0.20	50	$4.00 \times 10^{-2}$	$8.35 \times 10^{-5}$
2	0.60	50	$1.20 \times 10^{-1}$	$2.51 \times 10^{-4}$
3	1.00	50	$2.00 \times 10^{-1}$	$4.18 \times 10^{-4}$
4	3.00	50	$6.00 \times 10^{-1}$	$1.25 \times 10^{-3}$
5	4.00	50	$8.00 \times 10^{-1}$	$1.67 \times 10^{-3}$
6	6.50	50	1.30	$2.71 \times 10^{-3}$

#### 2. Standard Solution for High Initial Concentration Experiments

- A 0.80 g/L stock solution was obtained with dissolving 0.20 g reagent grade rhodamine B into 250 ml DI water. 10 ml stock solution was then diluted into 100ml solution with a concentration of  $8.00 \times 10^{-2}$  g/L (Dilution I).
- The concentrations of rhodamine B standard solution and the volume ratios of the Dilution I solution to DI water are summarized in Table A-2.

## Standard Curve

### 1. Standard Curve for Low Initial Concentration Experiments

Table 3. Standard Solution and its Absorbance

Standard ID	Absorbance at 554 nm	Concentration, mg/l	Concentration, mmol/l
1	0.019287	0.04	8.350E-05
2	0.041916	0.12	2.505E-04
3	0.067062	0.20	4.175E-04
4	0.161072	0.60	1.253E-03
5	0.204712	0.80	1.670E-03
6	0.34201	1.30	2.714E-03

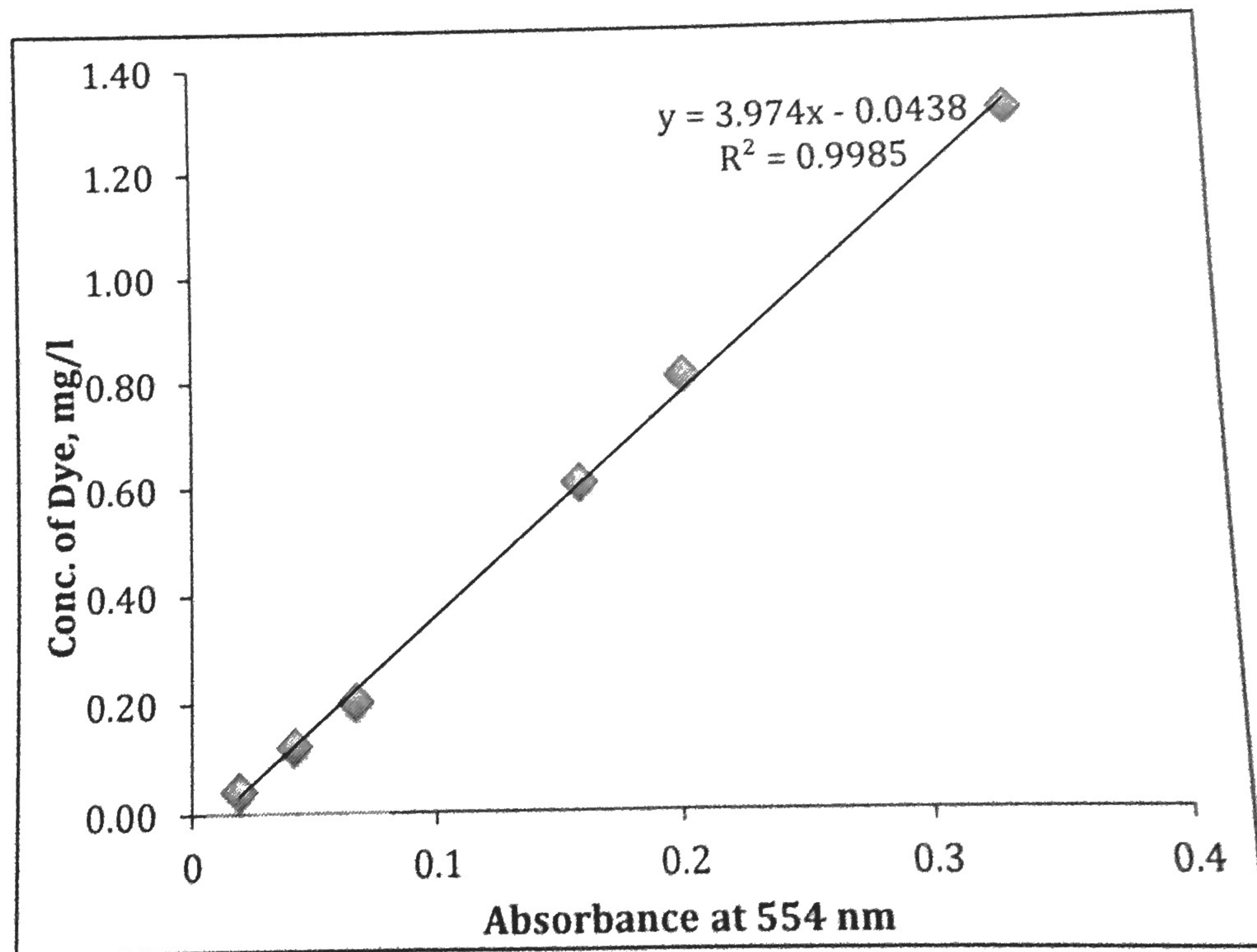


Figure 1. Calibration Curve Developed for Low Initial Concentration experiments