11-1-1976

Effects of Polyox in Fountain Solution

Jacob Varughese

EFFECTS OF POLYOX IN FOUNTAIN SOLUTION

by

Jacob Varughese

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in the School of Printing in the College of Graphic Arts and Photography of the Rochester Institute of Technology

November, 1976

Thesis advisor: Dr. Julius L. Silver

School of Printing
Rochester Institute of Technology
Rochester, New York

CERTIFICATE OF APPROVAL

____

MASTER'S THESIS

____

This is to certify that the Master's Thesis of

____
name of student

with a major in ___________________________________
has been approved by the Thesis Committee as satisfactory for the thesis requirement for the Master of Science degree at the convocation of

____
date

Thesis Committee: ______________________
Thesis Advisor

____
Graduate Advisor

____
Director or Designate

6924298

ACKNOWLEDGEMENTS

Among the many people who have directly or indirectly contributed to this research, there is one to whom I owe more than any other -- Dr. Julius L. Silver, my Thesis Advisor, for all his help and encouragement. I would like to extend my thanks to Mr. Chester Daniels, Mr. Bekir E. Arpag and Mr. Clair W. Fyke for their advice and for letting me use the instruments.

I also wish to thank the members of the Thesis Committee for their time in reviewing this research paper.

EFFECTS OF POLYOX IN FOUNTAIN SOLUTION

by
Jacob Varughese

AN ABSTRACT

A thesis submitted in partial fulfillment of the
requirements for the degree of Master of Science in the
School of Printing in the College of Graphic Arts and Photography
of the Rochester Institute of Technology

November, 1976

Thesis advisor: Dr. Julius L. Silver

ABSTRACT

"Polyox"[1] is a polymer of ethylene oxide. It is soluble in water and commercially available. The effects of Polyox in fountain solutions were studied and evaluated.

The same concentration (one-half percent of Polyox in water) at different pH and blending times, was tested for physical properties and printability. The physical property tests made were of viscosity, surface tension and contact angle. The printability tests were conducted as roll-up, ability to clean up the plate, resistance to scumming, printing sharpness and resolution properties.

The experiments were conducted under controlled press conditions and the properties of each test solution were reported.

Roll-up, the ability to clean up the plate, and resistance-to-scumming test were repeated five times and the average taken. Printing sharpness and resolution tests at high and low ink film thickness were run two times and 25 samples of each test were taken for obtaining the average.

The results show that the effect of Polyox in fountain solution is as good as standard fountain solution.

---

[1] "Polyox" is a trade mark of Union Carbide Corporation.

Abstract approved: ______________________________ Thesis Advisor

______________________________ Title and Department

______________________________ Date

TABLE OF CONTENTS

Table of Contents, continued

LIST OF TABLES

List of Tables, continued

LIST OF FIGURES

CHAPTER I

INTRODUCTION

In 1976, Alois Senefelder found that writing could be done on paper with a greasy fluid and transferred to stone. When the stone was washed with very dilute nitric acid and a thin coating of dissolved gum arabic solution, a clear impression of the writing could be printed. Thus lithography came into existence.[1]

Since the invention of lithography by Senefelder, offset printers have used gum arabic solutions in order to protect the non-printing areas of the plate.

> "If a cleanly polished plate is sprinkled with a few drops of gum arabic dissolved in water, the sprinkled places will take no color so long as they are wet. When they dry, color will adhere, but can be washed away easily with a wet sponge."[2]

Gum arabic is the dried juice taken from various species of acacia trees. They grow in warm places like Asia Minor, Sudan, Arabia and northern parts of Africa.[3] If gum arabic or any proper substitute is not added to fountain solutions on the continuous dampening system, the plate could become dry and eventually cause scumming on the printed sheets.[4]

The basic principle of offset lithography is that "ink and fountain solutions do not readily mix." Known as the planographic method, the image and non-image areas are on the same flat surface of a thin metal plate. On press, the image and non-image areas are separated chemically. The printing areas become grease receptive and water repellent; the non-printing areas become water receptive and thus ink repellent. While the press is running, the fountain solution dampens the non-printing areas of the plate and prevents these areas from accepting ink. At the same time, ink adheres to the printing areas of the plate and prevents the dampening solution from wetting the same areas. The printing image is transferred to the blanket cylinder and the papers pick up the ink image while it passes between the impression cylinder and the blanket cylinder.[5]

In early days, offset printers relied to a great extent on judgement and experience about press operation, particularly the mixing of fountain solutions. Research has eliminated much of the guesswork from this important factor of dampening control. There is no guarantee that clean and effective results can be achieved through a well prepared solution. Good results depend on more than fountain solution. Good results are dependent on the plate, ink, paper, press condition, etc.

Gum arabic in the fountain solution helps to prevent scratches on transfers. It is the most important desensitizing agent used in lithography. Before storing a plate, the platemaker applies a thin layer of the gum arabic over the plate to prevent scratches.

STATEMENT OF THE PROBLEM

Dampening is an important part of the lithographic process.

> "The requirement of dampening on an offset press is affected by plate, the dampening solution, ink and paper used. In addition to the problems from these sources, there are four major problems with dampening on an offset press that can affect the design and efficiency of a dampening system. These are the need for an ink-water balance on the press and time to re-establish it after a stop. The formation of water droplets on the image areas of the plate, achieving and maintaining an even distribution of moisture on and across the plate, and providing adequate reservoir capacity or response to compensate for sudden wide changes in demand for dampening solution."[6]

Gum arabic was the first natural resource used as a lithographic plate desensitizer and plate preservative by Senefelder. Since then, gum arabic has become one of the most precarious resources of lithography. Without it, printers would be in great trouble. The effects of different ingredients in fountain solutions on the total efficiency of the dampening operation have been studied by many researchers since 1796.

> "Research proved that alcohol can increase the absorption of gum arabic to the plate. However, when the pressman has little or no alcohol control, he may find excess alcohol will reduce the solubility of gum arabic and the gum deposit on the image area of the plate. The gum deposit will cause image blinding. This is a danger that a pressman must be aware of. Excess alcohol will cause other problems that could create plate makeovers."[7]

Early in 1974, there was a shortage of gum arabic. Due to war and politics, the distribution of gum arabic was interrupted. Natural disasters such as insects, floods, etc., also played a part in shortages of gum arabic. Due to growing world population and improved standards of living, the consumption of gum arabic has increased.[8]

Since gum arabic is imported from foreign lands, naturally the prices have gone up. Before the shortages, the price of gum arabic per gallon was between $3 and $5. After that, prices had gone to $10 per gallon.[9]

Substitutes for gum arabic have been tested since the invention of lithography, but without much success. Since the prices of gum arabic are high, printers are forced to limit the use of gum arabic or resort to other ingredients. Today, researchers continue to search for a possible substitute for gum arabic.

Polyox is a polymer of ethylene oxide and is a water soluble resin. Polyox fountain solution can keep longer than gum arabic solution without bacterial attack. Since the properties of Polyox have not been studied as a gum arabic substitute in lithography, it is worthwhile experimenting to study the effects of Polyox in fountain solutions.

THE PURPOSE

The purpose of this study was to find the effectiveness of Polyox in fountain solutions as a possible substitute for gum arabic. The variables tested for were viscosity, surface tension, contact angle, roll-up, the ability to clean up the plate, the resistance to scumming, printing sharpness and resolution.

Viscosity, surface tension and contact angles were measured by different instruments and tests were controlled throughout the experiments.

The ability to clean up the plate, roll-up, the resistance to scumming, printing sharpness and resolution were measured on the press. One press, different levels of pH, one kind of ink, one kind of plate and one kind of paper were used.

THE HYPOTHESIS

The hypothesis for this study is that if Polyox is used in a fountain solution in place of gum arabic under controlled press conditions, plate desensitizing will be equivalent or better. Plate desensitizing was determined by the degree of scumming ease, roll-up, the ability to clean up the plate, printing sharpness, resolution, viscosity, surface tension and the contact angles.

FOOTNOTES FOR CHAPTER I

[1]David Cummings, "Discovery and Application of Lithography", Handbook of Lithography, (London: McLagan and Cumming, Ltd., 1932), p. 3.

[2]J. W. Muller, "Gum as the Real Preparation", The Invention of Lithography, (New York: The Fuchs and Lang Manufacturing Company, 1911), p. 131.

[3]Cummings, pp. 37 - 38.

[4]Ralph F. Bock, "A Study of Lithographic Fountain Solutions", Graphic Arts Technical Foundation, (Pittsburgh, PA., 1973), pp. 224 - 232.

[5]"Offset Lithography", A Graphic Arts Production Handbook: Pocket Pal, (New York: International Paper Company, 1973), pp. 30 - 31.

[6]Michael H. Bruno, "Dampening Lithography's Oldest Problems", Modern Lithography, (October 1962), p. 62.

[7]Offset Lithoplate Making: "Alcohol in Conventional Dampening", Graphic Arts Monthly, (September 1972), pp. 121 - 122.

[8]Albert R. Materazzi,"Lithographic Chemical Shortages", Part 1, Graphic Arts Monthly, (February 1974), p. 86.

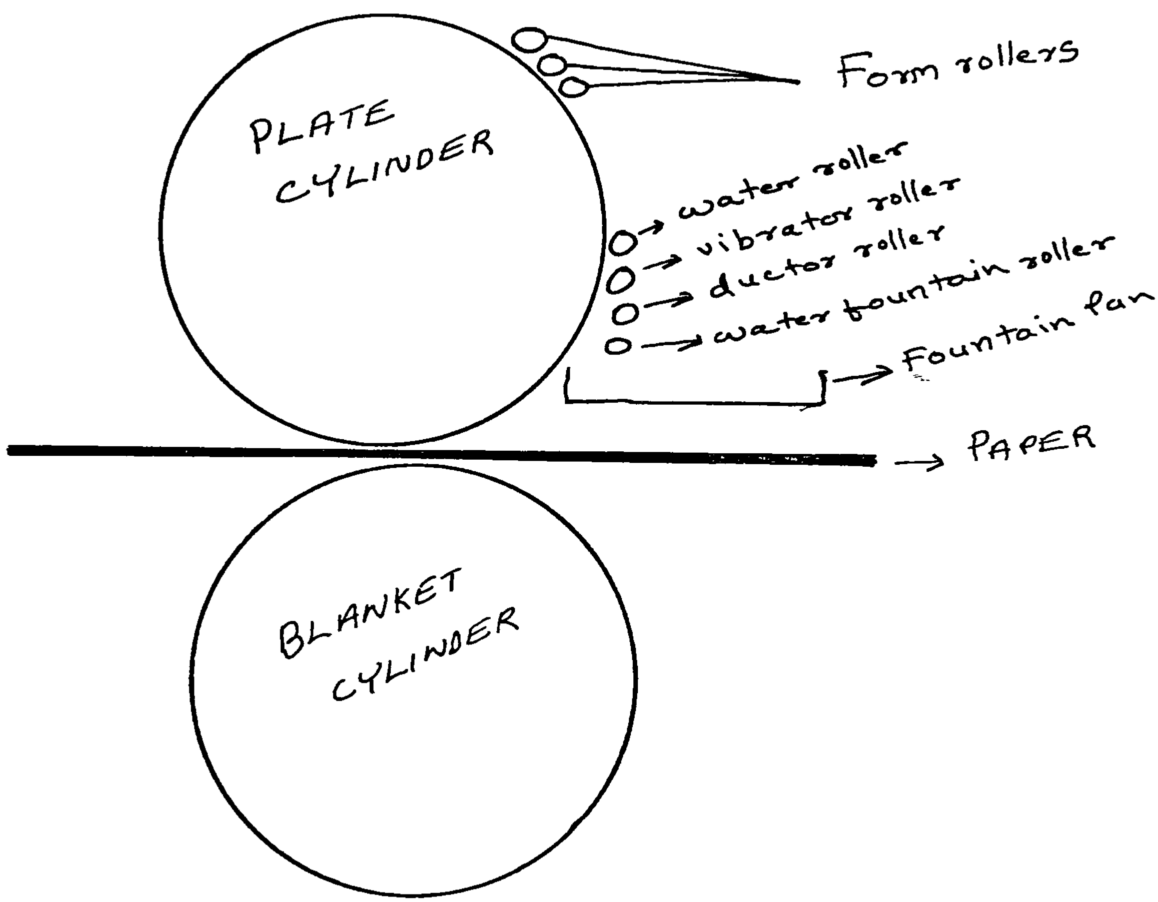
[9]Lane Olinghouse, "Gum Arabic Substitutes Can Reduce Printing Costs", In-Plant Printer, (July/August 1975), p. 86.

CHAPTER II

REVIEW OF THE LITERATURE

In offset printing, dampening is important. The offset plate consists of image and non-image areas. The image area is ink receptive and water repellent while the non-image area is water receptive and ink repellent. In this process, the plate is wet by a fountain solution, then with ink. The image is transferred to the blanket and from there to the paper.

Figure I. Drawing of dampening system in offset printing



If the press operator increases the speed of the press, it is easier to maintain the dampening solution on the plate.

The simplest method of determining pH is by the use of pHydroin Paper.[1] (Alkacid ribon test, Fisher Scientific Company, Chicago, Illinois) Its accuracy is about $\pm$ 0.25. By dipping the test paper into the solution and matching the color with the color standard on the side of the dispenser, the pH can be determined. The main purpose of pH is to make possible the standardization procedure to maintain uniformity.

> "Too little acid in the fountain solution can inhibit the gum arabic's ability to adhere to the no-image areas of the press plate. During the press run, the protective film of gum arabic needs a continual supply of replacement acid. Otherwise, the gum arabic molecules become dislodged from the plate and are replaced by ink molecules. This leads to a scumming situation."[2]

If the fountain solution is too alkaline, then the gum arabic film protecting the non-image area of the plate fails to adhere to the plate's surface and a replacement of the gum arabic molecules by ink molecules occurs. However, it is reported that by the usage of an alkaline based fountain solution; roller stripping does not occur, paper piling problems are reduced, and maintaining the fountain solution pH at any particular level proves less vital.[3]

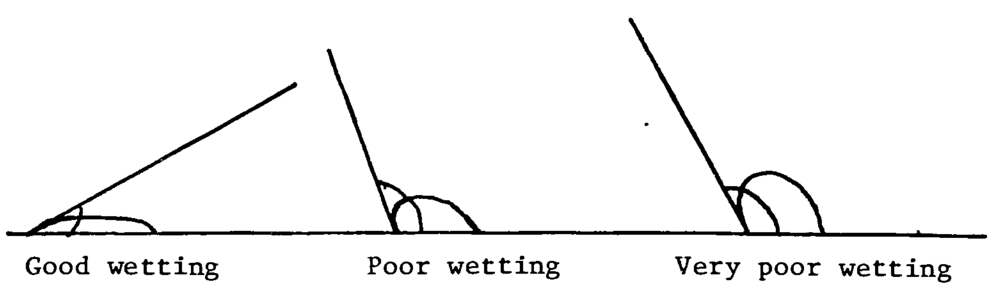
The pH factor plays an important role in obtaining good quality printing and in promoting trouble free press work.

When a liquid comes into contact with the surface of a solid substance, cohesion and adhesion forces come into play. Cohesion is the attraction of the body of molecules that are bound together. Adhesion is the attraction of two different bodies which are bound to each other. The better wetting is indicated by a smaller contact angle.[4]

Paul J. Hartsuch explains contact angle as:

> "Suppose you place a very small drop of water on a surface, for example, a lithographic plate. If a tangent line is drawn to the surface of the drop of water at the point where the drop touches the surface of the plate, then the angle between this tangent line and the surface of the plate is called the "contact angle." The angle must always be measured through the liquid, water, in this case. If the contact angle of a drop of water is low, it means that the metal surface is easily wet by the water. If the contact angle is high, the metal surface is not wet well by the water. Contact angles can vary from about 15° for a surface which is very well wet by water up to 130 - 140 degrees for a surface which is wet very poorly by water. These relations are shown in the sketches below."[5]

Figure II. Drawing of different angle of wetting.



R. A. C. Adams explains contact angles and their significance as:

> "The contact angle obtained is determined by the actual condition of the solid surface at the time of the experiment. Since under practical lithographic conditions, the metal surface is subjected to the action of the aqueous solutions, it is necessary to determine the contact angle relationship for the metals when they are being subjected to the simultaneous action of the two immiscible liquid phases rather than to determine the separate actions of these liquids."[6]

A conventional molleton dampening system was introduced in 1884 by E. Jack. The sponge system was patented by Cooper in 1868. The flow of fluid contained in a swab applicator was controlled by thumbscrew clamps to feed desired amount of fluid on the surface of the stone plate. J. Schultz invented a wick-fed device in 1934. This device delivered dampening fluid to the plate. In 1935, the same person introduced a device for dampening the pan roll on the press. In 1936, he made an improvement in his device.[7]

In offset lithography, water control is important. Poor dampening adjustment may cause slow drying of the sheet. It is impossible to produce a high quality job in the absence of good dampening control. The dampeners are set just tight enough to transfer the water. If the dampeners' set is too tight, water squeezes out and does not distribute evenly. Dampeners must be kept clean to do a good job.

In the past, substitutes have been studied but none work as well as gum arabic. Mesquite gum has been used in the fountain solution. This has a lower viscosity than gum arabic and, therefore, is easier to apply. It has poor desensitizing power, so its use is very limited as a plate preservative. The larch tree gum has found increasing use in offset processes, but it doesn't have the desensitizing power of gum arabic.

Mesquite and larch gum were more expensive than gum arabic. A few years ago, cellulose gum had been used widely in printing plants, but it resulted in poor ink receptivity of image area because it was too good a desensitizer and was not able to discriminate between the printing and non-printing parts of the plate.[8]

FOOTNOTES FOR CHAPTER II

[1]Charles W. Latham, "Establishing pH Control", American Printer, (February 1954), p. 61.

[2]Lane Olinghouse, "The pH Factor", Modern Lithography, (November 1972), p. 43.

[3]Olinghouse, "Alkaline - Based Fountain Solution", Modern Lithography, (August 1973), p.22.

[4]Henry A. Beechem, "Contact Angles", Graphic Arts Monthly, (December 1954), p. 64.

[5]Paul J. Hartsuch, "Contact Angles and Plate Wettability", Chemistry of Lithography, (Graphic Arts Technical Foundation, Inc., Pittsburgh, PA., January 1963), p. 105.

[6]R.A.C. Adams, "Contact Angles and Their Significance in Litho graphic Research", International Bulletin for the Printing and Allied Trades 73, (January 1956), p. 23.

[7]W.H. Wood, "Lithographic Dampening Devices", Modern Lithography, (January 1956), pp. 63 - 64.

[8]Albert R. Materazzi, "Lithographic Chemical Shortages", Graphic Arts Monthly, (February 1974), p. 90.

CHAPTER III

METHODOLOGY AND RESULTS

In order to determine the effectiveness of Polyox in a fountain solution, the test was conducted in two parts.

Part I. The physical properties such as viscosity, surface tension and contact angle of Polyox and standard fountain solutions were tested.

Part II. The printability of plates using Polyox and standard fountain solutions was examined. The test included roll-up, ability to clean up the plate, resistance to scumming, printing sharpness and resolution.

Standard fountain solution was supplied as a solution and was measured by volume/volume. Polyox was supplied as a solid and was measured by weight/volume. It is a polymer of ethelene oxide and available as a water soluble dry chemical.

In standard fountain solutions, two ounces of "RBP Blue Polyonic"[1] fountain concentration was mixed with one gallon of water. Polyox fountain solution was made using two grams of Polyox in 400 cc of water. The same concentration of Polyox fountain solution was used at different pH's and blending times to observe any change. To change the acidity of the solution, phosphoric acid was used. The pH ranged from 3.00 to 5.00. "Photo Volt"[2] pH meter scale 112 was used. A Waring blender at 120 volts was used for the experiment. Blending times ranged from 15 to 35 minutes.

The press and other testing conditions were kept constant. The controlled variables and test objects are shown in Appendices A and B.

TEST PROCEDURES

PART I: THE PHYSICAL PROPERTY

The physical property test was conducted in three main divisions:

A. Viscosity
B. Surface tension
C. Contact angle

A. Viscosity

Viscosity is a measure of the resistance of a liquid to flow. The Brookfield Synchro-Lectric Viscometer Manufacturer's formula is:

$$\text{Viscosity} = \frac{\text{Shear stress}}{\text{Rate of shear}}$$ [3]

The viscosity of the solution was measured by the Brookfield Synchro-Lectric Viscometer Model RVT. The viscometer was adjusted according to the manufacturer's instructions before taking the measurements.

The same amount of solution and same beaker were used for each reading. The beaker was cleaned and dried thoroughly in between solutions. The amount of solution, the beaker and the cleaning were controlled because viscometer ranges will change if different amounts and different sizes of beakers are used.

The solutions were placed in a beaker. Then the viscometer was lowered into the fluid. To make the measurement, RV Spindle Number 1 was chosen and inserted in the fluid. A speed of 100 rpm was used to obtain the reading. After letting the unit run for awhile, a scale reading for sample of "13" was obtained. According to the manufacturer's manual, the formula for RV Spindles is:[4] $V = D \times F$.

V = Viscosity

D = Dial reading

F = Factor

To find the factor, Chart A from the manufacturer's manual was used for fountain solutions. Looking on Chart A, a value of 1 was determined for spindle number 1. Dial reading indicated a viscosity of 13 and a factor number of 1. Therefore, viscosity 13 centipoise (cps) was calculated by multiplying 13 x 1.

Polyox resins shear while solutions are stirred with consequent changes in viscosity in water. To obtain true solutions, it is necessary to blend Polyox for longer time periods. In this experiment, pH was varied from 3.00 to 4.00 and blending time from 15 to 35 minutes; the viscosity decreases as the blending time increases. At pH's of 4.50 to 5.00 at same blending time, the viscosity does not vary in a simple fashion as seen on Table I. With lower acidity the viscosity varies with blending times.

The viscosity of Polyox fountain solutions was measured at a concentration equal to one-half percent of Polyox in water. (2.00 grams/ 400 cc water) Blending time varied from 15 to 35 minutes and pH varied from 3.00 to 5.00. The viscosity of Polyox fountain solution ranged from 8.50 to 16.50 centipoise. The lowest viscosity was at pH 3.00 at blending time of 35 minutes and the highest viscosity was at pH 4.00 at blending time of 15 minutes.

The viscosity of the standard fountain solution was measured at different concentrations. The concentration range was 0.4 to 2.00 oz/ gallon of water. The viscosity of standard fountain solutions ranged from 4.50 to 10.50 centipoise. The viscosity of the standard fountain solution was highest at 2.00 oz/gallon and the lowest was at 0.4 oz/gallon.

The collected data obtained is shown in Tables I and II. (page 18)

The relationship between viscosity and blending time of Polyox solution is shown in Figure III; (page 19) the relationship between viscosity and changes of pH is shown in Figure IV; (page 20) the relationship between viscosity and the concentration of standard fountain solution is shown in Figure V. (page 21)

TABLE I

THE VISCOSITY OF POLYOX SOLUTION AT SAME CONCENTRATION, DIFFERENT BLENDING TIME AND DIFFERENT pH.

Concentration 2 grams/400 cc	Viscosity (CPS) vs. Blending time (minutes)				
pH	15	20	25	30	35
3.00	11.00	10.50	10.00	9.50	8.50
3.50	15.00	13.50	12.00	10.50	9.00
4.00	16.50	14.00	13.00	12.00	10.50
4.50	13.00	12.00	11.00	13.00	13.50
5.00	14.50	12.50	11.50	14.00	12.00

TABLE II

THE VISCOSITY OF STANDARD FOUNTAIN SOLUTION AT DIFFERENT CONCENTRATIONS.

Concentration oz/gallon	Viscosity (CPS)
0.4	4.50
0.8	6.00
1.2	8.00
1.6	9.50
2.00	10.50

FIGURE III. RELATIONSHIP BETWEEN VISCOSITY AND BLENDING TIME OF POLYOX SOLUTIONS OF 1/2 PERCENT.

Code:

pH	
3.00	xxxxxxxxxxxxxxxxxxxx
3.50	――――――――――――
4.00	------------------
4.50	....
5.00	++++++++++++++++++

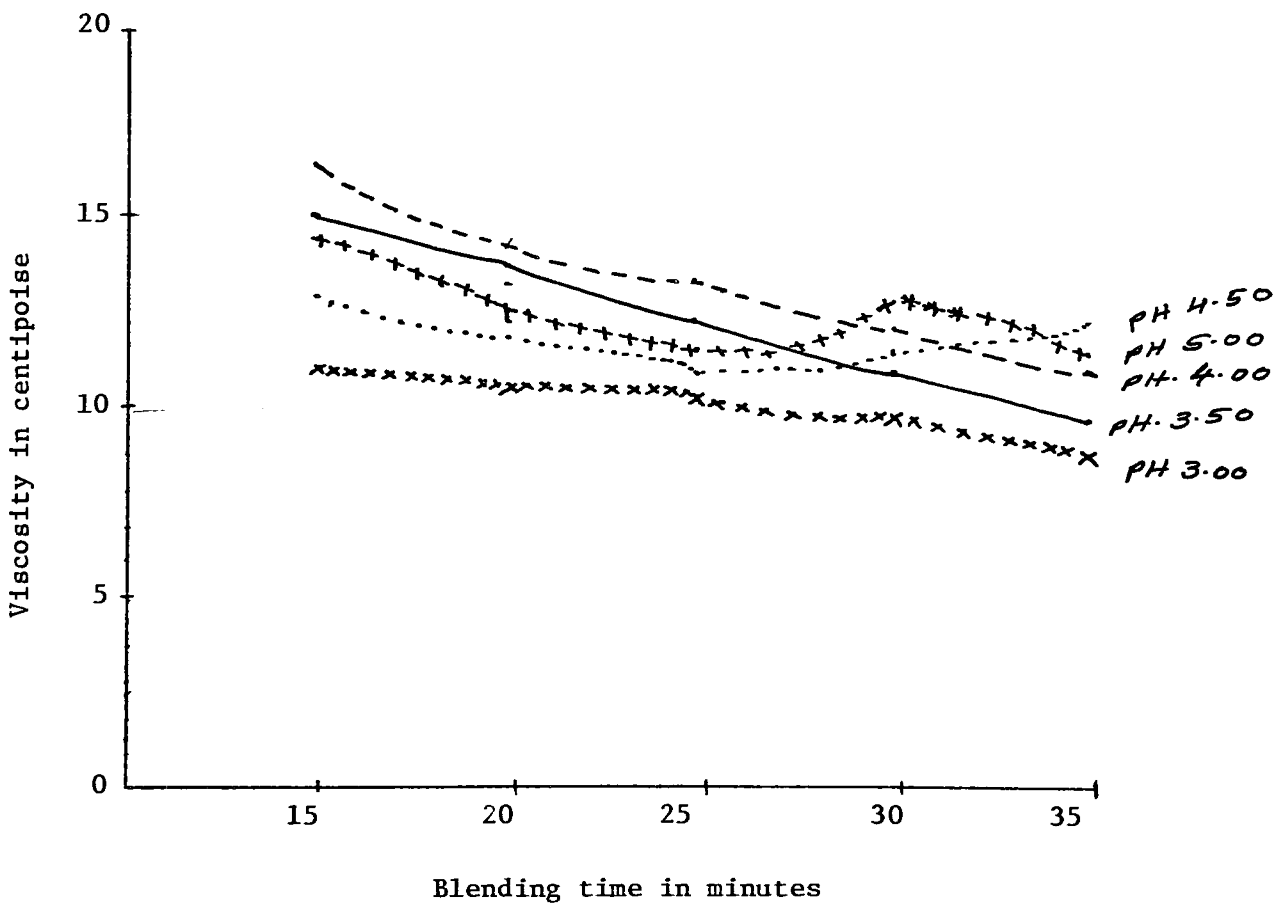


FIGURE IV: RELATIONSHIP BETWEEN VISCOSITY AND CHANGES OF pH.

Blending time/minutes

15 xxxxxxxxxxxxxxxxxxxx

20 ____________________

25 ------------------

30 ....

35 +++++++++++++++++++

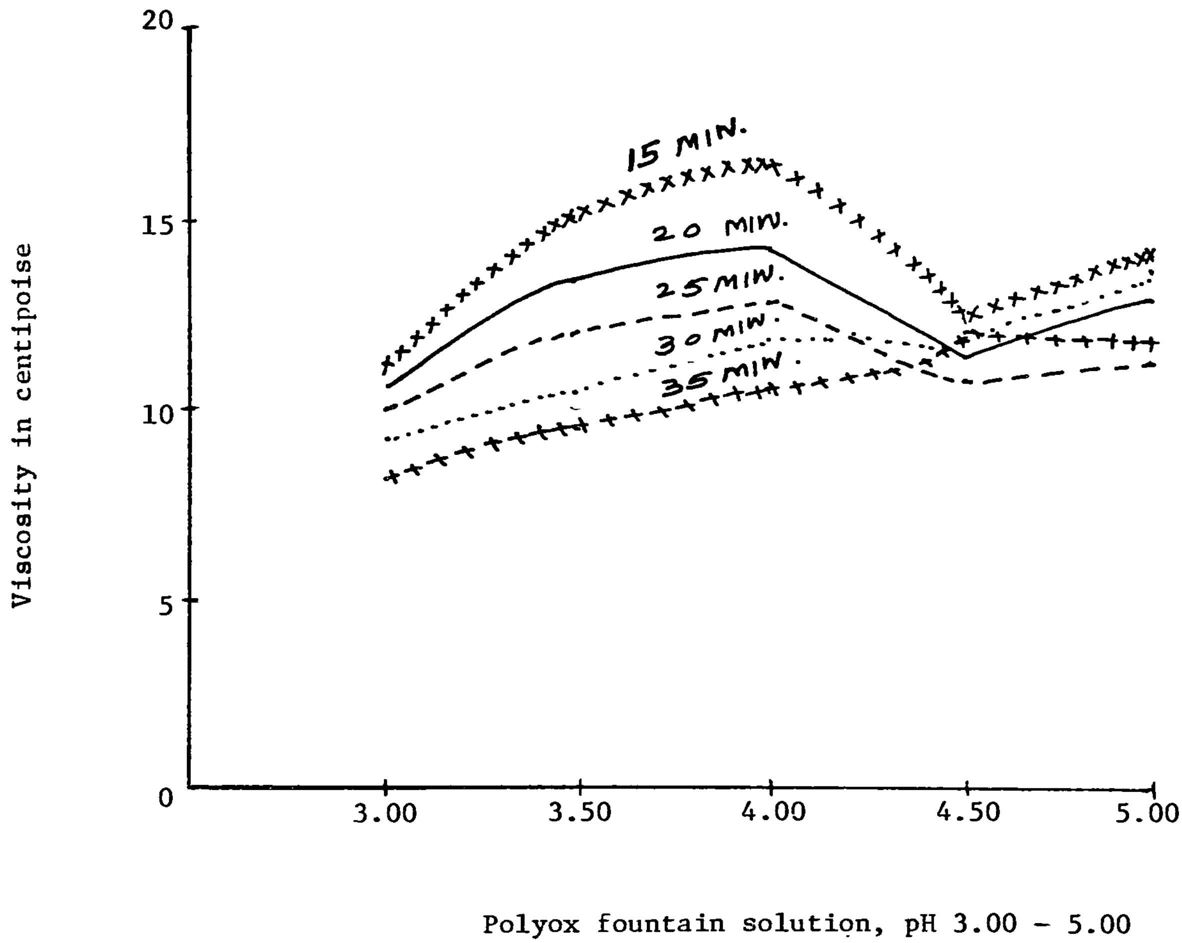
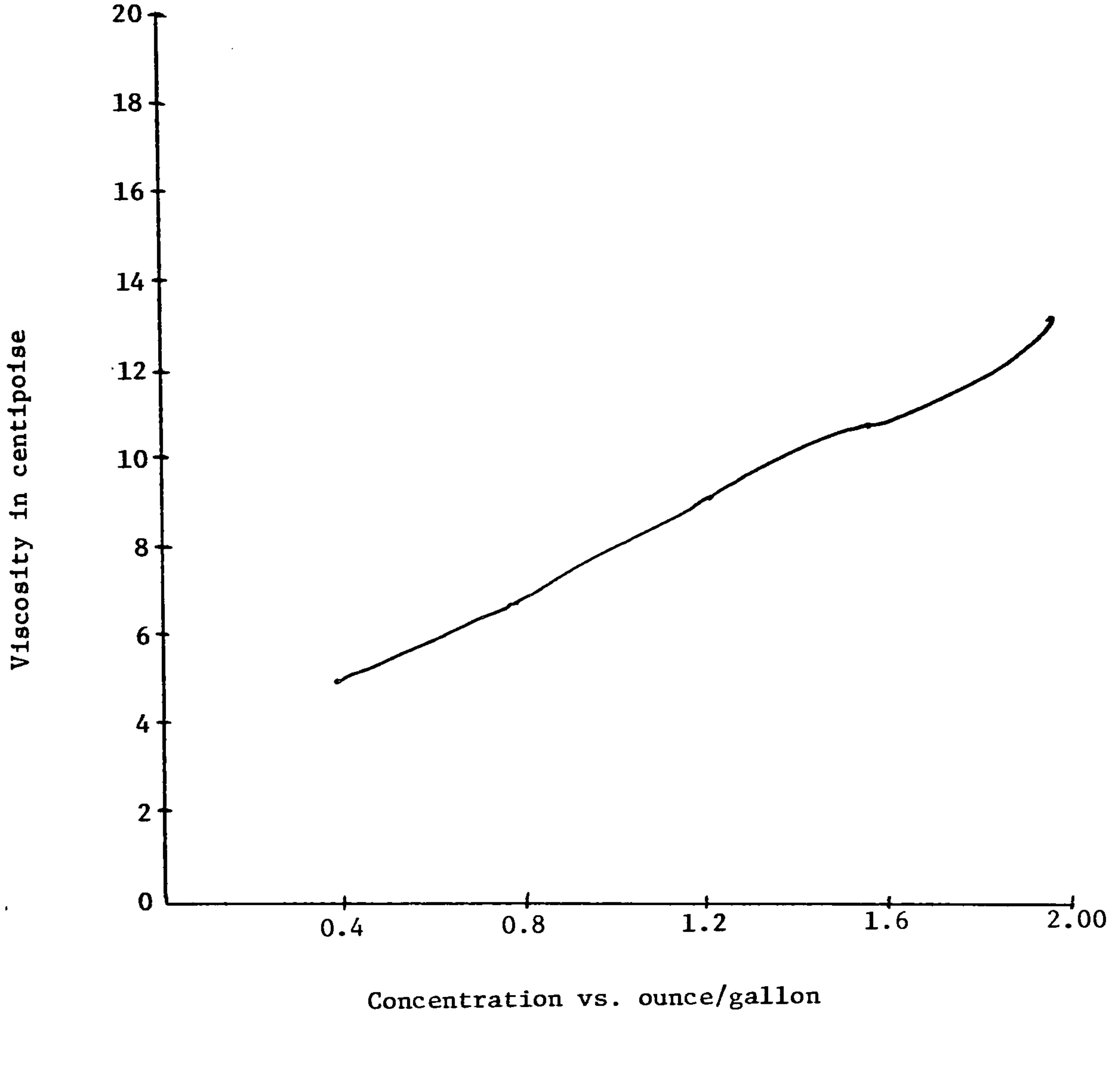


FIGURE V: RELATIONSHIP BETWEEN VISCOSITY AND CONCENTRATION OF STANDARD FOUNTAIN SOLUTION.



B. Surface tension

> "Surfaces of liquids behave as if they had stretched over them a membrane; the measurement of this force is called "surface tension." Surface tension may be defined as tension of the surface of a liquid acting on both sides of an imaginary unit length in the surface. In the c.g.s. system this tension is measured in dynes per cm. The surface tension is usually measured between air and water."[5]

To determine the surface tension of the solution, a jolly balancer was used. The numbers are given in grams on the jolly balancer's frame. The light weight spring and platinum wire frame on the balancer are connectable in order to measure the surface tension of a liquid. The platinum wire frame and the beaker were thoroughly cleaned in between each measurement in order to prevent mixing of the solutions.

After placing the solution into a container, the test was made. The platinum wire frame was lowered into the liquid until the platinum wire just touched the surface of the liquid. Then a reading was taken from the scale. The platinum wire frame was released from the liquid surface by turning the thumb screw clockwise slowly. The final reading was taken. The difference between them was found. Five readings were taken and the average calculated.

According to the manufacturer's instructions, the formula is:

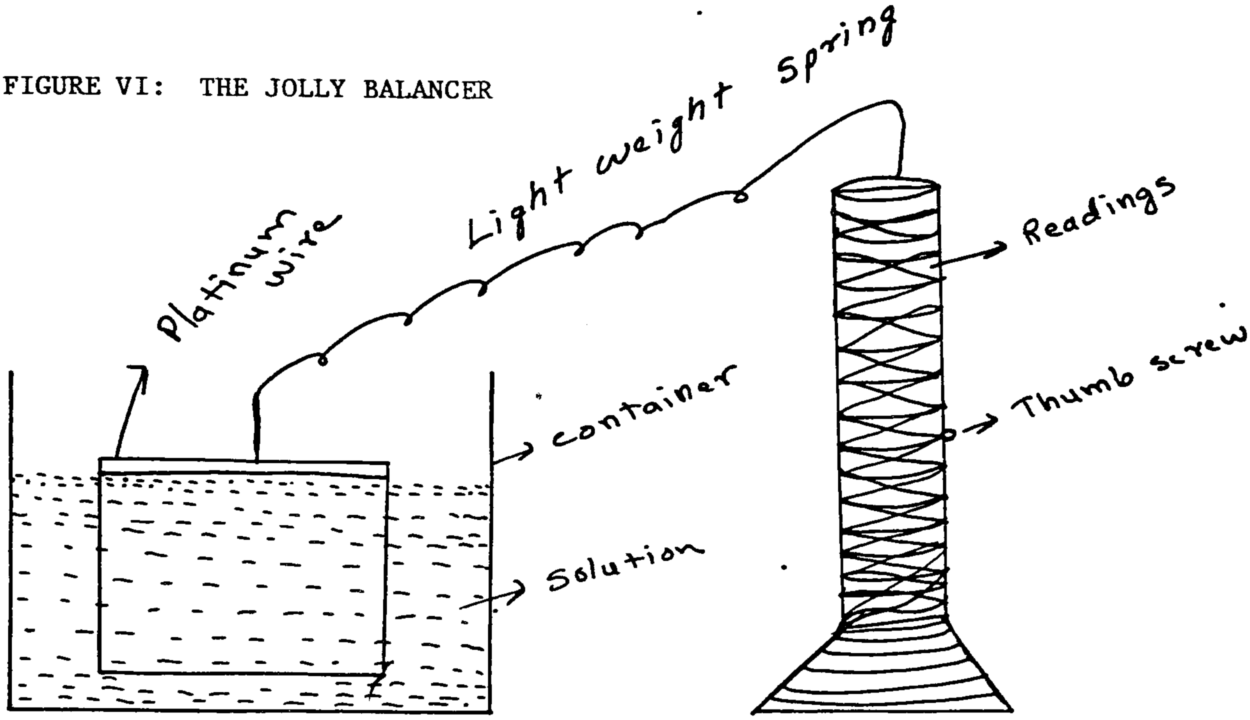
$$T = (13.49)\ X \text{ in dynes/cm.}$$

T = Surface tension

X = Average from the readings

For example, if the average reading is 5.11 cm., then the surface tension is 13.49 x 5.11 = 68.93 dynes/cm.

FIGURE VI: THE JOLLY BALANCER



The surface tension of the standard fountain solution was measured at different concentrations. The concentration range was 0.4 to 2.00 ounce per gallon of water. The surface tension ranged from 73.44 to 81.30 dynes/cm. The surface tension of the solution at the highest = 1.6 and the lowest = 0.4 as seen in Table IV. (page 24)

The surface tension of Polyox fountain solutions were measured at the fixed concentration of 1/2 percent. Blending time varied from 15 to 35 minutes and pH varied from 3.00 to 5.00. The surface tension of Polyox fountain solutions ranged from 64.01 to 69.81 dynes/cm. The lowest surface tension was at pH of 5.00 at 20 minutes blending time and the highest was at pH of 3.00 at 35 minutes blending time.

The data obtained are shown in Tables III and IV. (page 24)

The relationship between surface tension and blending time of Polyox is shown in Figure VII;relationship between surface tension and changes of (page 25) pH is shown in Figure VIII; relationship between surface tension and con- (page 26) centration of standard fountain solution is shown in Figure IX. (page 27)

TABLE III

THE SURFACE TENSION OF POLYOX FOUNTAIN SOLUTION AT SAME CONCENTRATION, DIFFERENT BLENDING TIME AND DIFFERENT pH.

Concentration 2 grams/400 cc	Surface tension (dynes/cm.) vs. Blending time (minutes).				
pH	15	20	25	30	35
3.00	68.70	68.90	66.85	67.65	69.81
3.50	65.36	67.92	66.85	68.74	66.37
4.00	67.65	68.87	67.25	67.79	67.25
4.50	64.16	65.23	64.82	65.50	65.09
5.00	67.38	64.01	66.44	66.31	66.98

TABLE IV

THE SURFACE TENSION OF STANDARD FOUNTAIN SOLUTION AT DIFFERENT CONCENTRATIONS.

Concentration oz/gallon	Surface tension (dynes/cm.)
0.4	73.44
0.8	74.94
1.2	81.01
1.6	81.30
2.00	74.69

FIGURE VII: RELATIONSHIP BETWEEN SURFACE TENSION AND BLENDING TIME OF POLYOX SOLUTIONS:

pH

3.00 xxxxxxxxxxxxxxxxxxxxx

3.50 ________________

4.00 ------------------

4.50 ....

5.00 +++++++++++++++++++

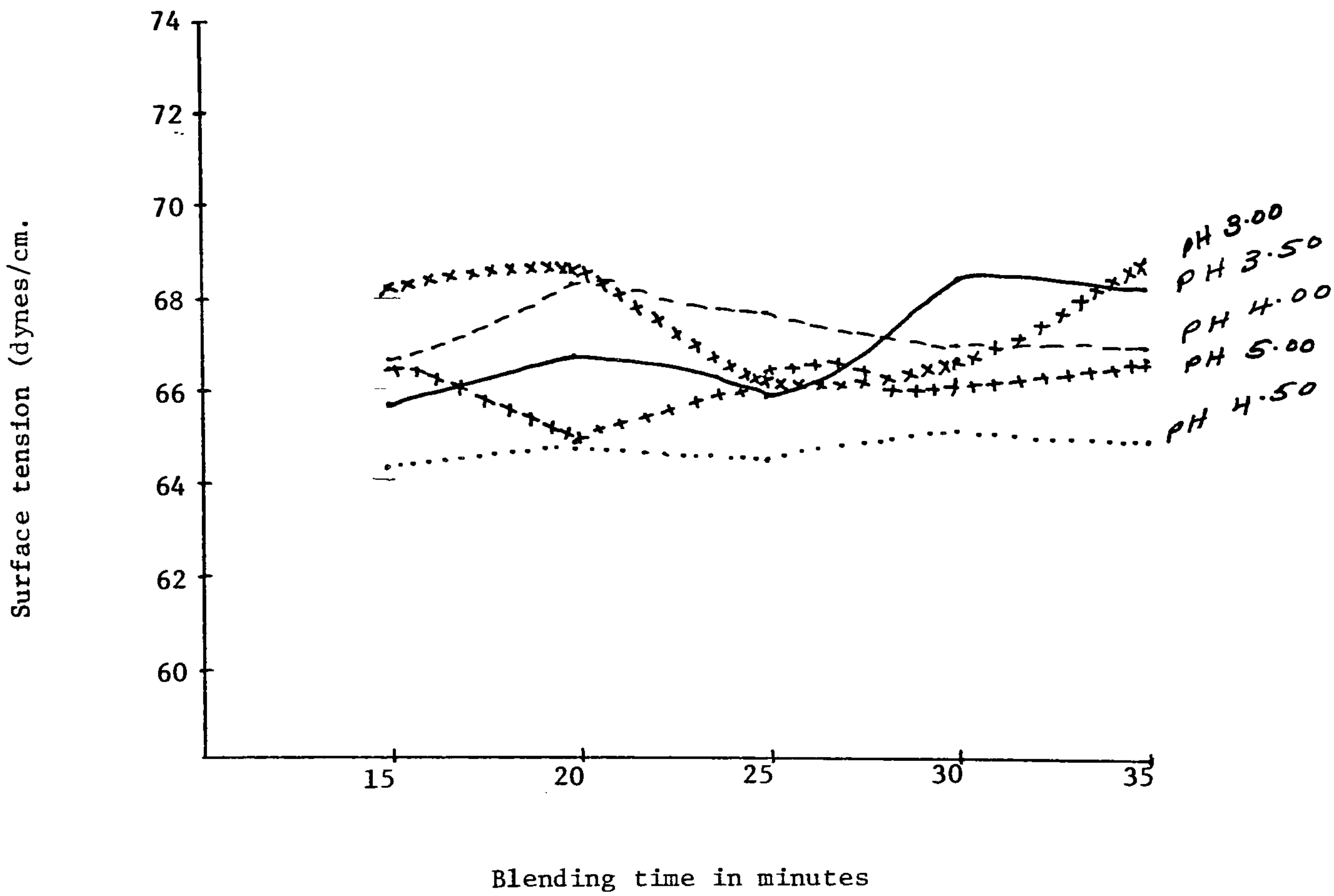


FIGURE VIII: RELATIONSHIP BETWEEN SURFACE TENSION AND CHANGES OF pH:

Blending time in minutes

15 xxxxxxxxxxxxxxxxxxxxxx

20 ____________________

25 --------------------

30 ....

35 ++++++++++++++++++++

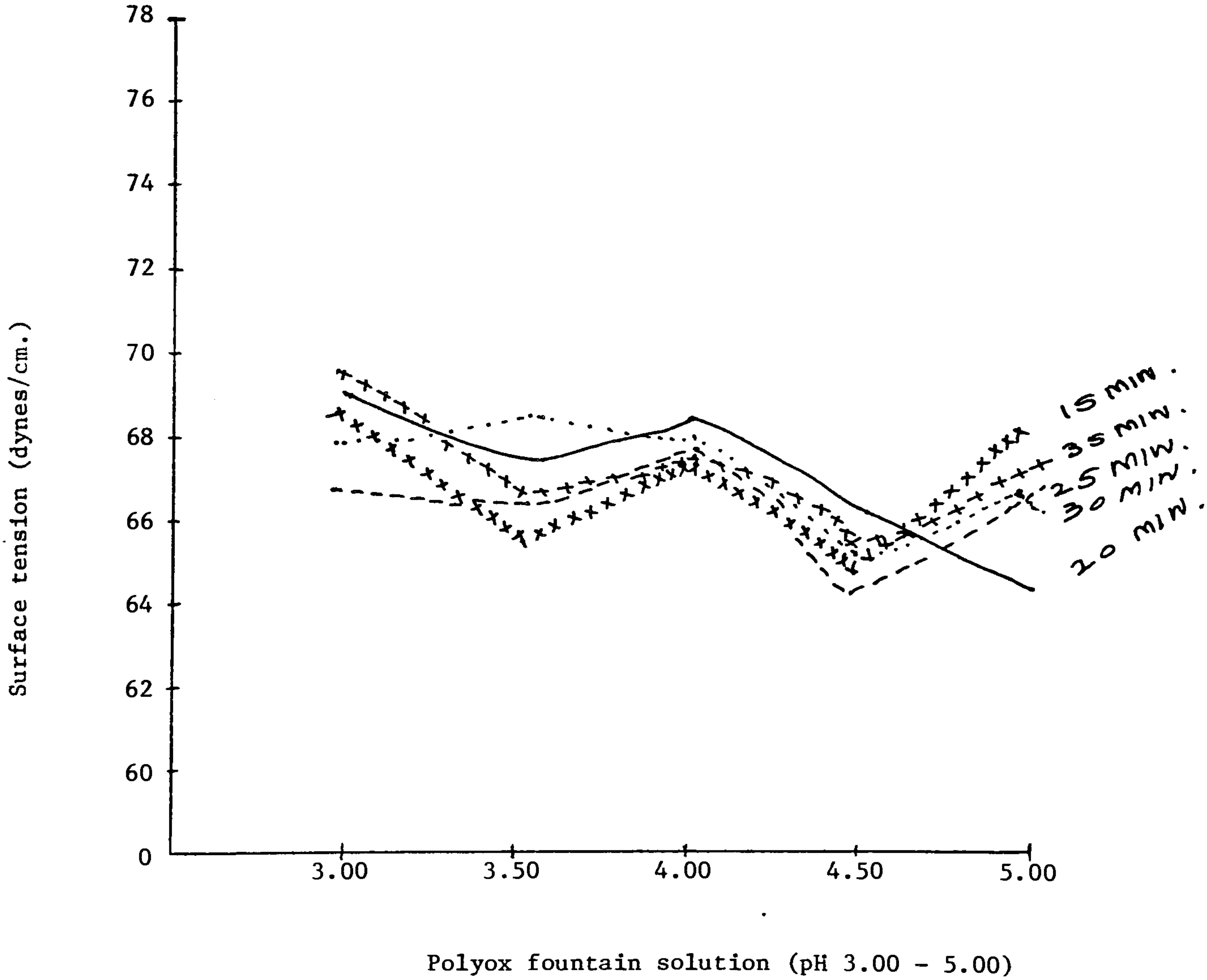
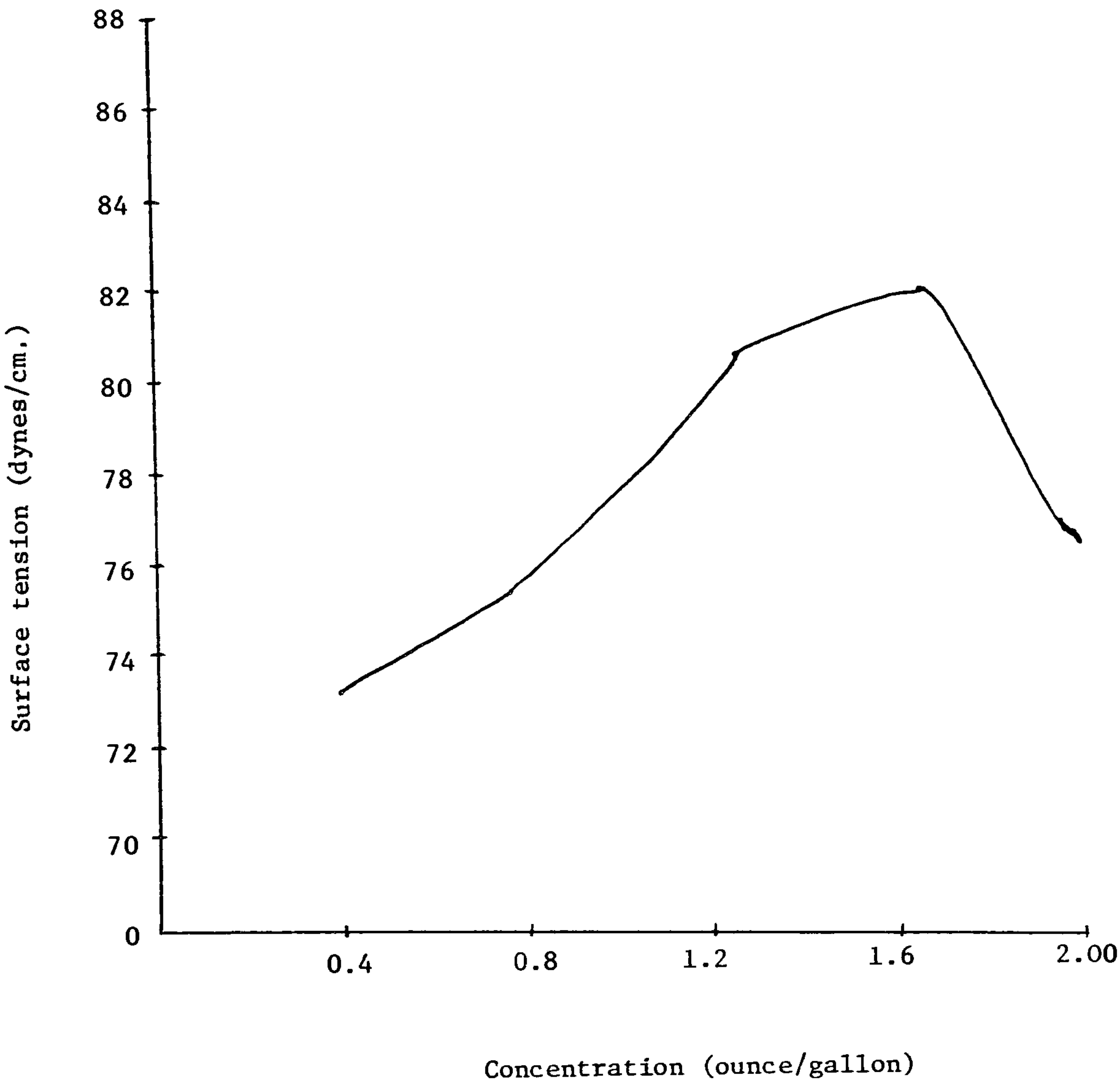


FIGURE IX: RELATIONSHIP BETWEEN SURFACE TENSION AND CONCENTRATION OF STANDARD FOUNTAIN SOLUTION.



C. Contact angle

> "The wetting characteristics of the surface of an offset plate is of prime importance. To measure the wettability of a surface such as zinc, aluminum, copper and metals, a drop of water is placed on the surface and the angle that this drop of water makes, where it contacts the surface, is determined. This is called the contact angle. The lower it is, the less the amount of dampening solution required to keep the plate running clean."[6]

The contact angle of Polyox fountain solution was measured at the same concentration. Blending time and pH were varied.

The contact angle of standard fountain solution was measured at different concentrations. The concentration range was from 0.4 to 2.00 ounces per gallon of water.

A photographic method was used to obtain the contact angle. The photographic technique diagram is shown in Figures X to XII. (pages 31-32)

The desensitized "Enco N-2 Plate"[7] was placed on a flat surface. A piece of frosted glass was fixed to one side of the plate as shown in Figure X. A light was passed through the frosted glass. A drop (page 31) of each fountain solution was placed, one at a time, on the non-image of a desensitized Enco N-2 Plate, using a dropper. As soon as the drop was placed on the plate's surface, a picture of the drop was taken, using a 35mm single lens Cannon camera. The film used was black and white 35mm Kodak Panatonic.

After taking pictures of each experimental solution the film was developed and put through the photographic enlarger as shown in Figure XI. When the light passed through the film, the picture of each drop (page 32) reflected on a flat base.

A piece of paper was placed on the base and a drawing of center line and angleline of the drop was done as shown in Figure XII. (page 32) After that, using the protractor, the angles were measured.

The contact angle results show that as the blending time of the Polyox increases, the contact angle decreases. When the pH increases, the contact angle decreases. (Table V, page 30)

For the standard fountain solution, as the concentration increases, the contact angle decreases.

The data obtained is shown in Tables V and VI. (page 30)

The relationship between the contact angle and the blending time of Polyox solution is shown in Figure XIII: (page 33) the relationship between the contact angle and the changes of pH is shown in Figure XIV; (page 34) the contact angle versus the concentration of the standard solution is shown in Figure XV. (page 35)

TABLE V

THE CONTACT ANGLE OF POLYOX FOUNTAIN SOLUTION AT SAME CONCENTRATION, DIFFERENT BLENDING TIME AND DIFFERENT pH.

Concentration 2 grams/400 cc	Contact angle degrees vs. blending time (minutes)				
pH	15	20	25	30	35
3.00	21.50	21.00	20.00	19.50	18.00
3.50	24.50	23.00	22.50	21.00	19.50
4.00	27.00	25.00	23.00	21.50	20.50
4.50	30.50	28.00	27.50	26.00	23.50
5.00	34.00	33.50	33.00	32.00	31.50

TABLE VI

CONTACT ANGLE OF STANDARD FOUNTAIN SOLUTION AT DIFFERENT CONCENTRATIONS.

Concentration oz/gallon	Contact angle (degrees)
0.4	18.00
0.8	16.00
1.2	14.00
1.6	13.00
2.00	12.00

FIGURE X: DIAGRAM OF PHOTOGRAPHIC METHOD OF TAKING PICTURES OF THE DROPS.

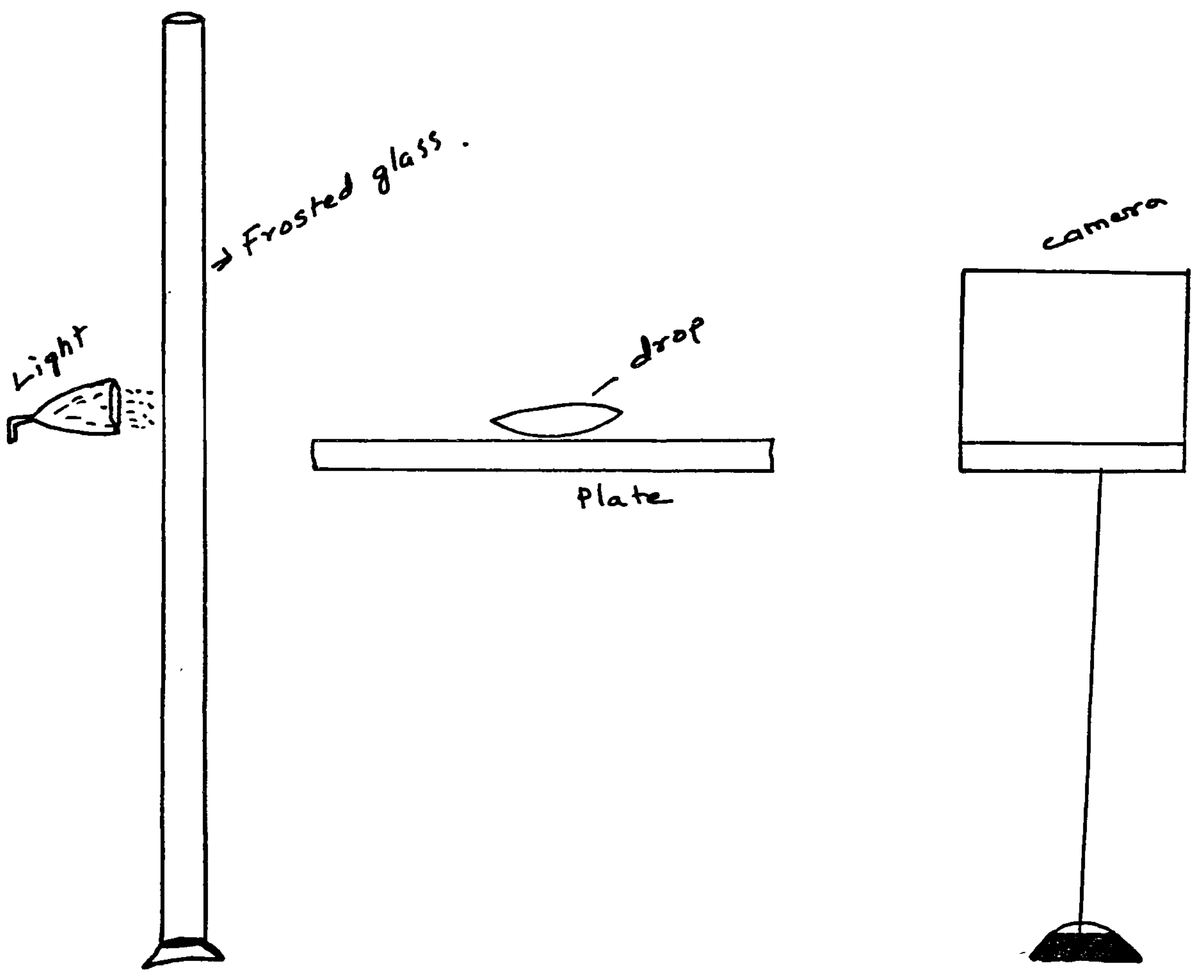


FIGURE XI: DIAGRAM OF MEASURING THE ANGLES WHEN THE FILM IS PUT THROUGH THE PHOTOGRAPHIC ENLARGER.

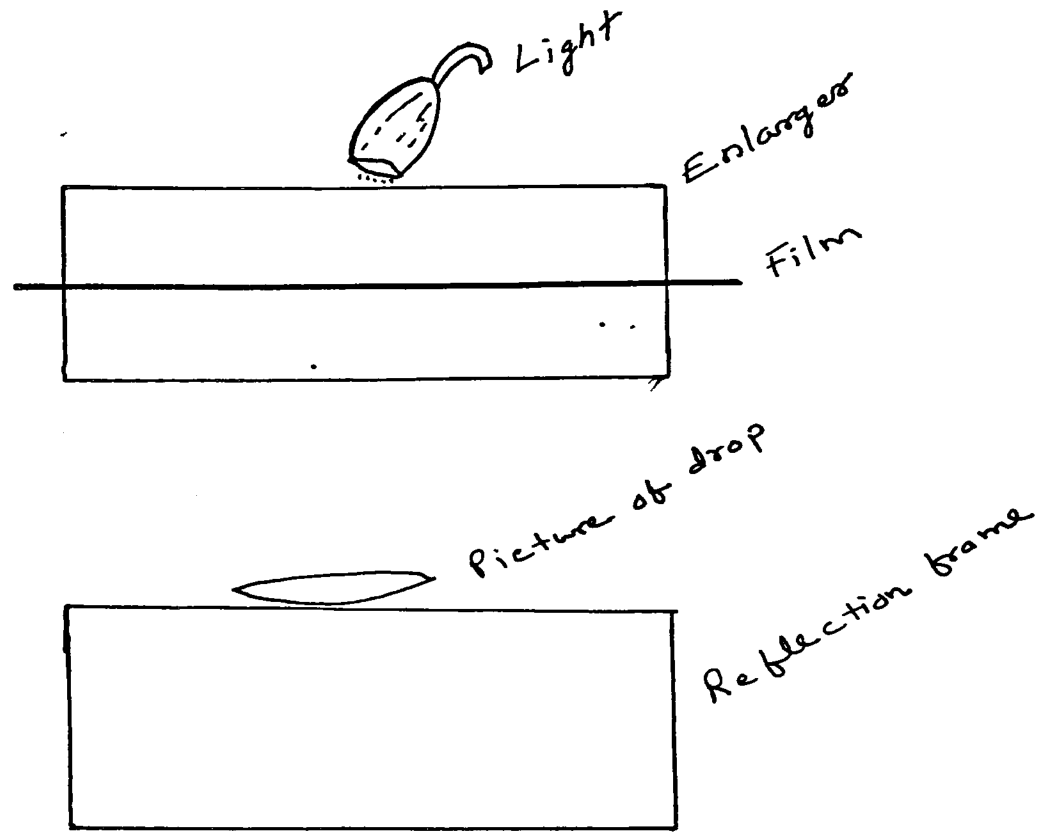


FIGURE XII: METHOD OF MEASURING THE CONTACT ANGLES.

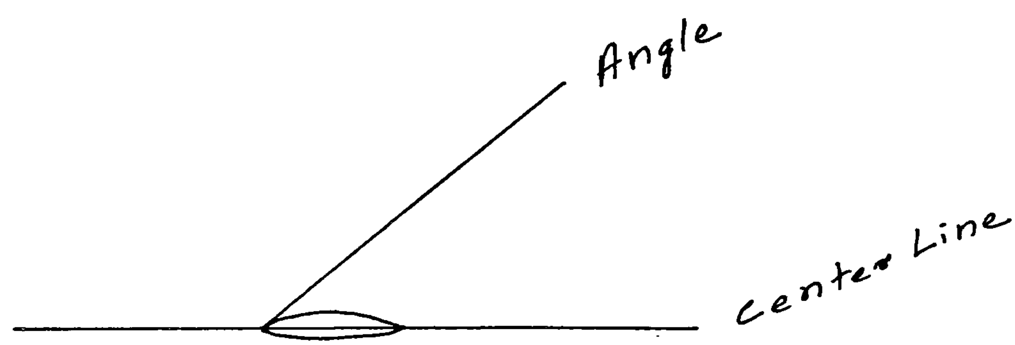


FIGURE XIII: RELATIONSHIP BETWEEN CONTACT ANGLE AND BLENDING TIME OF POLYOX SOLUTION.

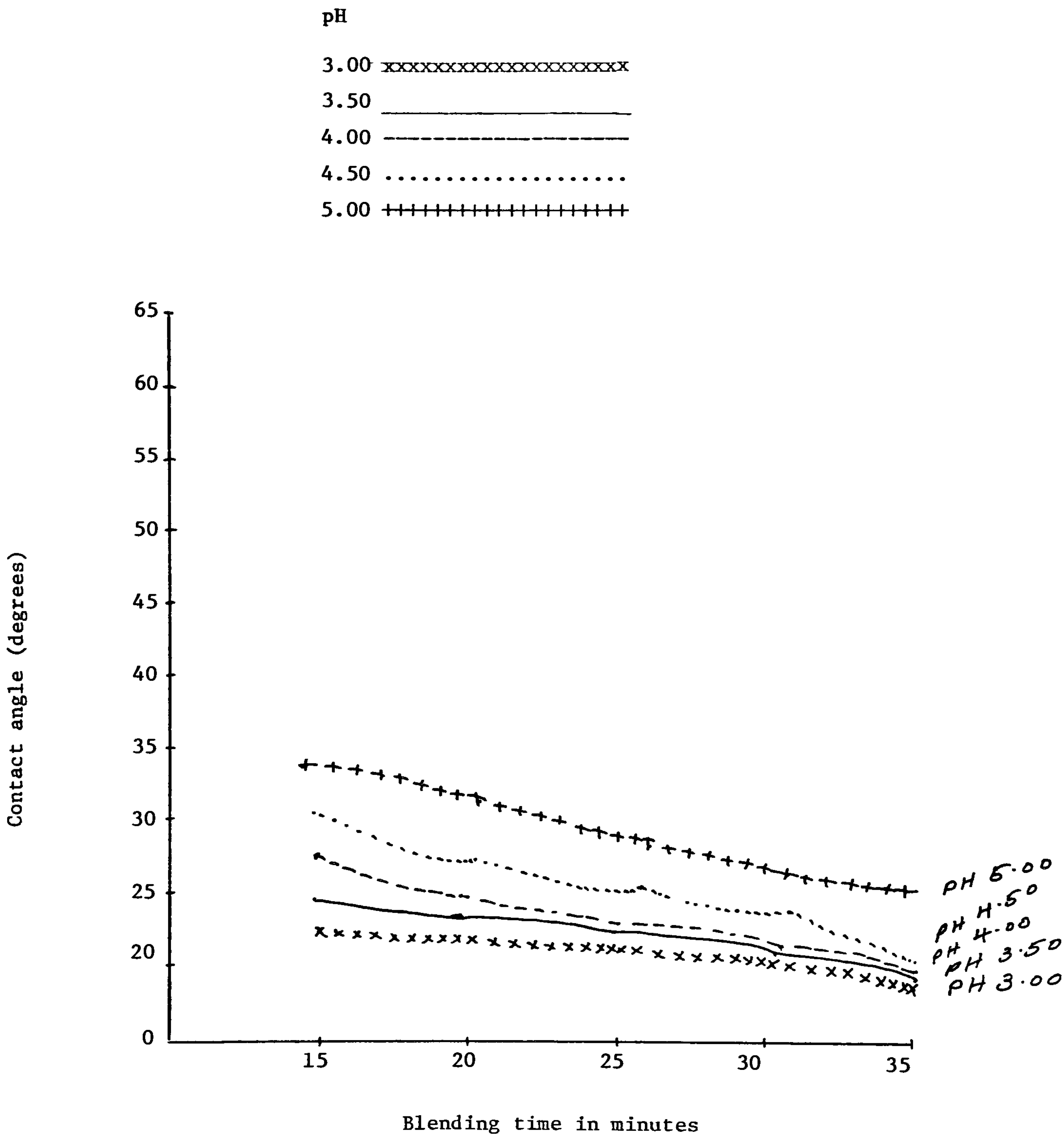


FIGURE XIV: RELATIONSHIP BETWEEN CONTACT ANGLE AND CHANGES OF pH.

Blending time in minutes

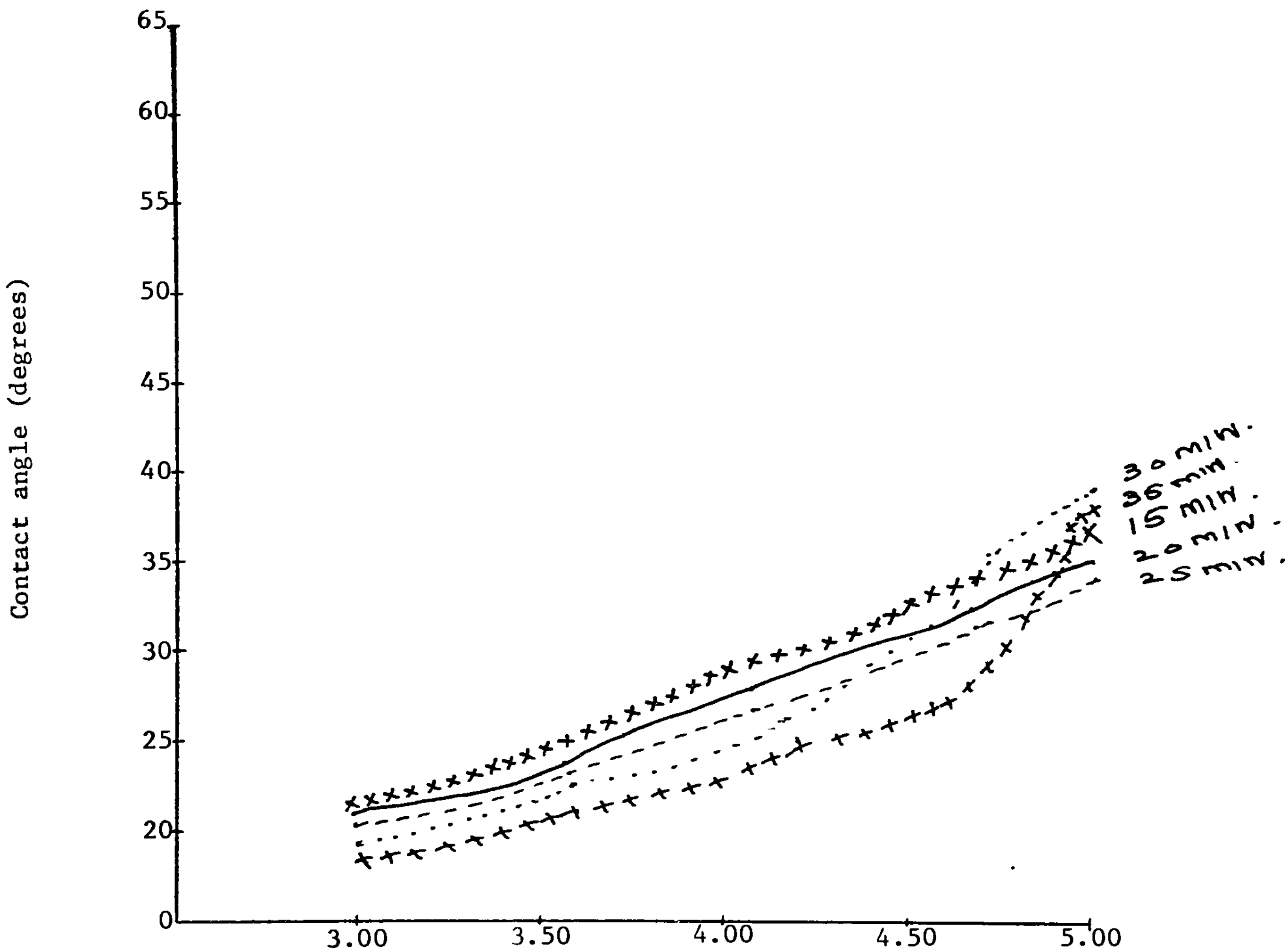
15 xxxxxxxxxxxxxxxxxxxx

20 ____________________

25 ------------------

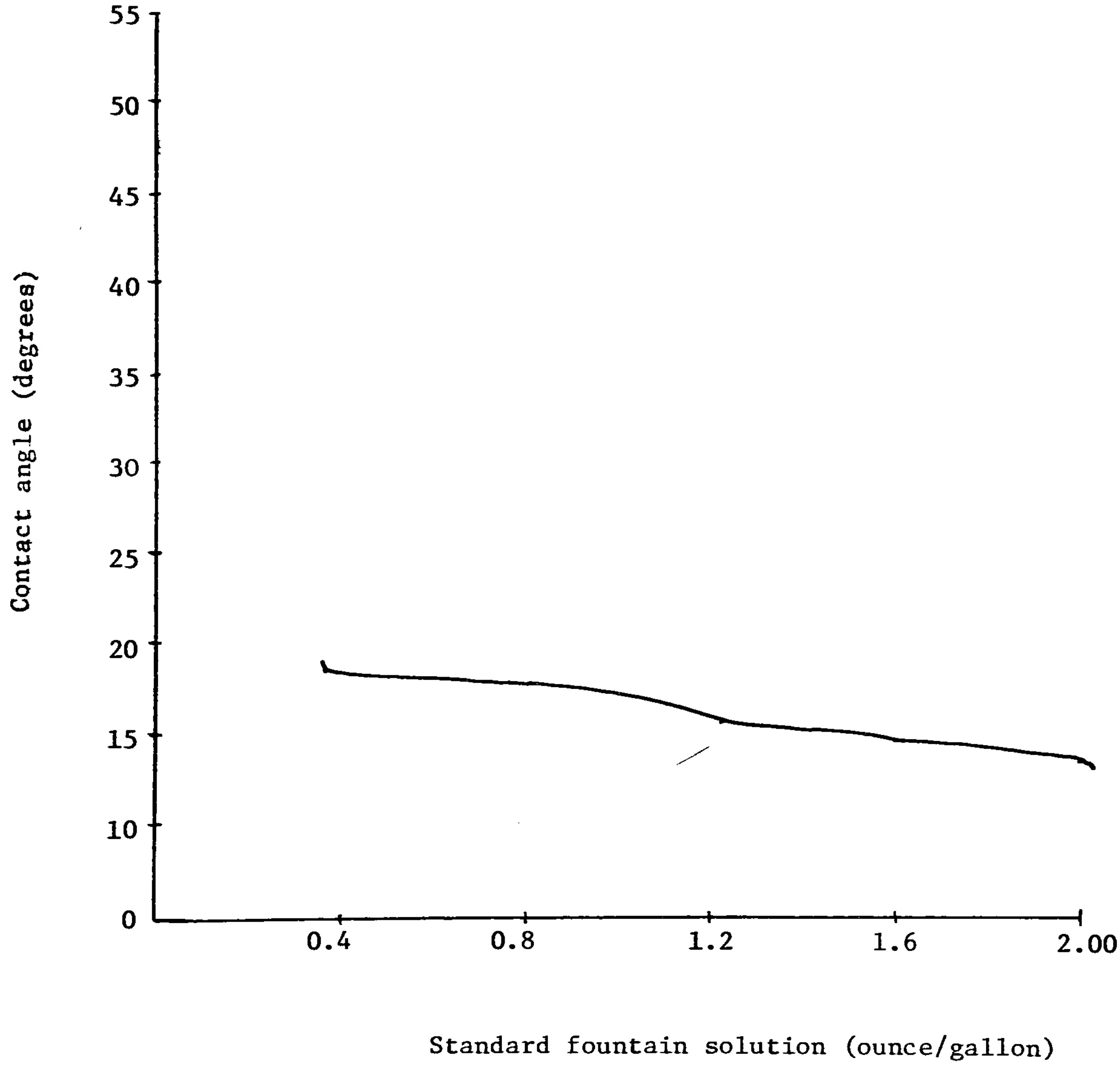
30 ....

35 +++++++++++++++++++



Polyox fountain solution (pH 3.00 - 5.00)

FIGURE XV: RELATIONSHIP BETWEEN CONTACT ANGLE AND DIFFERENT CONCENTRATION OF STANDARD FOUNTAIN SOLUTION.



PART II: PRINTING PERFORMANCE CHARACTERISTICS

Tests were performed using controlled variables such as press conditions, plate, paper, ink, blanket and pH of the fountain solutions in order to determine the printing characteristics. The tests were conducted for:

A. Roll-up
B. The ability to clean up the plate
C. Resistance to scumming
D. Printing sharpness
E. Resolution

The standard fountain solution was mixed in two ounces of RBP Blue Polyonic Fountain Concentration per one gallon of water. The pH was 4.00. Polyox solutions in water of 1/2 percent were used. (Equal to 2.00 grams of Polyox and 400 cc. of water) The blending time and pH were varied. Blending times ranged from 15 minutes to 35 minutes and pH ranged from 3.00 to 5.00. Under the controlled conditions, the different concentrations were used in the fountain solution on the press one at a time.

There was not much problem in adjusting ink and water balance in any one of the concentrations. The ink on paper dried at good rates. There were not any offset problems on backs of the printed sheets.

The concentration with pH 4.00 and blending time of 35 minutes gave results which were as good as did the standard fountain solution.

A. TEST FOR ROLL-UP

The image area picked up ink and the non-image area picked up water when the form rollers and the dampener rollers were placed on the plate.

After placing the ink and fountain solutions in each fountain, the press was run until the ink rollers picked up the ink and the dampener rollers picked up the fountain solutions. They were dropped on the plate and sheets were run to find how many sheets were needed before getting good images. There were five runs for each test. In between each run the plate and blanket were cleaned thoroughly. Before changing each test solution, the fountain was cleaned to prevent mixing of solutions.

The collected data are shown in Tables VII to XII. (pages 37-39)

TABLE VII

THE TEST FOR ROLL-UP WITH STANDARD FOUNTAIN SOLUTIONS:

Concentration vs. oz/water	0·4	0·8	1·2	1·6	2·0
Number of runs	1	2	3	4	5
Number of sheets per run	2	1	1	2	1
	Total sheets:			7	
	Average			1.40	

TABLE VIII

THE TEST RESULTS OF "ROLL-UP" ON POLYOX FOUNTAIN SOLUTION WITH DIFFERENT pH AND BLENDING TIME:

B.T. = blending time

M = minutes

Concentration vs. 2.00 g/400 cc. water	Number of runs 1	2	3	4	5	Total	Average
pH 3.00/B.T. 15 M	6	3	5	4	5	23	4.60
pH 3.00/B.T. 20 M	5	4	4	3	6	22	4.40
pH 3.00/B.T. 25 M	4	4	5	3	5	21	4.20
pH 3.00/B.T. 30 M	4	3	4	3	5	19	3.80
pH 3.00/B.T. 35 M	3	4	3	4	4	18	3.60

TABLE IX

pH 3.50/B.T. 15 M	4	3	3	4	3	17	3.40
pH 3.50/B.T. 20 M	3	4	3	3	3	16	3.20
pH 3.50/B.T. 25 M	5	4	3	3	3	15	3.00
pH 3.50/B.T. 30 M	3	3	4	2	2	14	2.00
pH 3.50/B.T. 35 M	3	3	2	2	3	13	2.60

TABLE X

pH 4.00/B.T. 15 M	2	3	2	2	3	12	2.40
pH 4.00/B.T. 20 M	2	2	3	2	2	11	2.20
pH 4.00/B.T. 25 M	2	2	2	2	2	10	2.00
pH 4.00/B.T. 30 M	2	1	2	2	1	8	1.60
pH 4.00/B.T. 35 M	1	2	1	1	1	6	1.20

TABLE XI

Concentration vs. 2.00 g/400 cc. water	Number of runs 1	2	3	4	5	Total	Average
pH 4.50/B.T. 15 M	3	4	3	4	4	18	3.60
pH 4.50/B.T. 20 M	4	5	3	4	3	19	3.80
pH 4.50/B.T. 25 M	3	4	3	3	3	16	3.20
pH 4.50/B.T. 30 M	4	5	3	2	3	17	3.40
pH 4.50/B.T. 35 M	3	4	4	4	4	19	3.80

TABLE XII

pH 5.00/B.T. 15 M	3	3	2	3	2	13	2.60
pH 5.00/B.T. 20 M	3	4	2	3	2	14	2.80
pH 5.00/B.T. 25 M	3	3	3	4	3	16	3.20
pH 5.00/B.T. 30 M	3	4	3	4	4	18	3.60
pH 5.00/B.T. 35 M	3	4	4	3	3	17	3.40

B. TEST FOR THE ABILITY TO CLEAN UP THE PLATE

The main function of the fountain solution is to clean up the non-image areas of the plate and maintain dampening on the non-image area. Good fountain solutions take less time to clean up the plate while the press runs.

In this test, the well prepared plate was put on the press and over inked by lifting the dampening rollers. The inking time was approximately 20 seconds. Then the dampening form rollers were dropped down on to the plate and the sheets were fed through to find out how many sheets were needed for cleaning the plate. The test was repeated five times per each concentration. In between each run the plate and the blanket were well cleaned. Before changing each test solution, the fountain was well cleaned to prevent the mixing of the solutions. In each test, sheets were counted to find how many sheets were used to obtain clean prints and good images. They were totaled and the average taken.

The collected data are shown in Tables XIII to XVIII. (pages 40-42)

TABLE XIII

THE TEST RESULT OF THE ABILITY TO CLEAN UP THE PLATE WITH STANDARD FOUNTAIN SOLUTION:

Concentrations vs. oz/water	0·4	0·8	1·2	1·6	2·0
Number of runs	1	2	3	4	5
Number of sheets per run	17	19	16	18	16

Total sheets: 86

Average: 17.20

TABLE XIV

THE TEST RESULTS OF THE ABILITY TO CLEAN UP THE PLATE WITH POLYOX FOUNTAIN SOLUTION WITH DIFFERENT pH AND BLENDING TIME:

Concentration 2.00 g/400 cc.	Number of runs 1	2	3	4	5	Total	Average
pH 3.00/B.T. 15 M	20	25	24	22	25	116	23.20
pH 3.00/B.T. 20 M	23	24	19	23	22	111	22.20
pH 3.00/B.T. 25 M	19	22	23	21	20	105	21.00
pH 3.00/B.T. 30 M	21	20	19	22	22	104	20.80
pH 3.00/B.T. 35 M	20	21	21	22	20	104	20.80

TABLE XV

pH 3.50/B.T. 15 M	24	21	23	21	24	113	22.60
pH 3.50/B.T. 20 M	21	23	22	21	23	110	22.00
pH 3.50/B.T. 25 M	22	21	21	22	22	108	21.60
pH 3.50/B.T. 30 M	21	20	21	22	21	105	21.00
pH 3.50/B.T. 35 M	21	20	20	21	20	102	20.40

TABLE XVI

pH 4.00/B.T. 15 M	20	21	21	20	20	102	20.40
pH 4.00/B.T. 20 M	19	20	21	19	20	99	19.80
pH 4.00/B.T. 25 M	19	19	20	20	19	97	19.40
pH 4.00/B.T. 30 M	18	19	19	18	20	94	18.80
pH 4.00/B.T. 35 M	18	19	18	18	19	92	18.40

TABLE XVII

pH 4.50/B.T. 15 M	23	21	22	23	23	112	22.40
pH 4.50/B.T. 20 M	22	22	21	23	22	110	22.00
pH 4.50/B.T. 25 M	22	21	20	21	22	106	21.20
pH 4.50/B.T. 30 M	21	24	23	22	24	114	22.80
pH 4.50/B.T. 35 M	21	22	21	22	23	109	21.80

TABLE XVIII

Concentration 2.00 g/400 cc.	Number of runs 1	2	3	4	5	Total	Average
pH 5.00/B.T. 15 M	21	22	21	22	22	108	21.60
pH 5.00/B.T. 20 M	23	21	23	21	23	111	22.20
pH 5.00/B.T. 25 M	24	21	24	21	24	114	22.80
pH 5.00/B.T. 30 M	21	21	20	21	20	103	20.60
pH 5.00/B.T. 35 M	20	21	22	21	21	105	21.00

C. TEST FOR RESISTANCE TO SCUMMING

The non-image areas of the plate tend to accept the ink. There are numbers of reasons involved and they are as follows:[8]

1. The improper adjustment of dampeners.
2. Use of greasy ink.
3. Poorly desensitized plate.
4. The plate wear on the press.
5. The plate drying on the press while the press is idling.
6. Use of dirty dampeners.
7. Too much ink form rollers' pressure on plate.
8. Too much blanket pressure on plate.

The experiment was conducted as follows: The testing solution ran on the press until it dampened the dampener rollers. The press ran until the ink picked up on the image areas and the water prevented the ink from adhering to the non-image areas. Then the dampening form rollers were lifted up and sheets were allowed to run. The better the fountain solution's resistance to scumming, the more sheets it can print without scumming. The test was run five times per each test solution. In between each run the plate and the blanket were well cleaned. Before placing each test solution in the fountain, the pan was cleaned well to prevent the intermixing of each.

The collected data are shown in Tables XIX to XXIV. (Pages 44-45)

TABLE XIX

THE RESULT OF RESISTANCE TO SCUMMING WITH STANDARD FOUNTAIN SOLUTION:

concentrations vs. oz/water	0·4	0·8	1·2	1·6	2·0
Number of runs	1	2	3	4	5
Number of sheets per run	6	4	5	4	5

Total sheets: 24

Average: 4.80

TABLE XX

THE TEST RESULT OF RESISTANCE TO SCUMMING OF POLYOX WITH DIFFERENT pH AND BLENDING TIME:

Concentration 2.00 g/400 cc.	Number of runs 1	2	3	4	5	Total	Average
pH 3.00/B.T. 15	5	6	8	6	7	32	6.40
pH 3.00/B.T. 20	6	5	7	6	6	30	6.00
pH 3.00/B.T. 25	5	6	6	7	5	29	5.80
pH 3.00/B.T. 30	6	5	5	6	5	27	5.40
pH 3.00/B.T. 35	5	5	6	5	5	26	5.20

TABLE XXI

pH 3.50/B.T. 15	6	5	6	7	6	30	6.00
pH 3.50/B.T. 20	6	5	5	6	6	28	5.60
pH 3.50/B.T. 25	5	5	6	5	5	26	5.20
pH 3.50/B.T. 30	5	6	6	5	3	25	5.00
pH 3.50/B.T. 35	5	6	5	5	3	24	4.80

TABLE XXII

Concentration 2.00 g/400 cc.	Number of runs 1	2	3	4	5	Total	Average
pH 4.00/B.T. 15	6	5	5	6	5	27	5.40
pH 4.00/B.T. 20	6	5	5	4	5	25	5.00
pH 4.00/B.T. 25	5	4	4	5	4	22	4.40
pH 4.00/B.T. 30	4	4	5	4	4	21	4.20
pH 4.00/B.T. 35	4	4	4	4	4	20	4.00

TABLE XXIII

pH 4.50/B.T. 15	6	5	5	6	6	28	5.60
pH 4.50/B.T. 20	6	5	6	5	3	25	5.00
pH 4.50/B.T. 25	5	6	5	6	5	27	5.40
pH 4.50/B.T. 30	6	5	5	3	5	24	4.80
pH 4.50/B.T. 35	6	6	5	5	5	27	5.40

TABLE XXIV

pH 5.00/B.T. 15	6	5	6	7	6	30	6.00
pH 5.00/B.T. 20	5	6	5	7	6	29	5.80
pH 5.00/B.T. 25	5	6	5	6	5	27	5.40
pH 5.00/B.T. 30	6	5	6	7	6	30	6.00
pH 5.00/B.T. 35	6	5	6	6	5	28	5.60

D. PRINTING SHARPNESS

The printing sharpness was evaluated on the printed sheets. The printed sheets were evaluated by dividing the density of tint by the density of solid. For example, on Table XXV (page 47) sample one high ink film thickness first run, density of tint was .52 and density of solid was .99. Dividing .52 by .99 is equal to 0.525 and multiplied by 100 is equal to 52.53.

The measurement was taken by using the densitometer. The test was run two times per high and low ink film thickness. The solid density was 1.25 $\pm$ .05 for high ink film thickness and 0.95 $\pm$ .05 for low ink film thickness. The best test materials were selected and 25 samples per high and low ink film thickness were taken for evaluation.

The collected data are shown in Tables XXV to XXVI. (Page 47-48)

TABLE XXV

PRINTING SHARPNESS VALUES PRINT FROM STANDARD FOUNTAIN SOLUTION AT BOTH HIGH INK FILM THICKNESS (1.25± .05) AND LOW INK FILM THICKNESS(0.95± .05)

Sample	High ink film thickness 1st run	High ink film thickness 2nd run	Low ink film thickness 1st run	Low ink film thickness 2nd run
1	52.53	54.67	50.00	55.65
2	59.00	56.00	53.33	54.24
3	57.60	55.79	46.73	49.89
4	51.82	50.86	46.80	48.34
5	52.27	51.45	56.62	54.78
6	56.56	55.98	50.51	52.75
7	52.73	53.46	54.00	53.70
8	56.00	54.97	51.00	52.95
9	52.73	55.80	57.14	54.60
10	56.00	53.80	50.00	52.90
11	51.02	52.60	54.44	56.80
12	53.06	54.68	52.22	50.00
13	54.00	52.97	50.54	53.81
14	56.57	57.50	54.54	52.97
15	52.73	50.84	51.65	53.67
16	52.52	55.80	50.51	52.78
17	51.82	50.70	51.00	50.79
18	54.00	55.90	53.53	55.55
19	55.55	53.70	54.12	52.60
20	53.00	54.60	54.88	55.80
21	55.68	55.89	55.00	56.90
22	56.64	54.90	54.69	53.80
23	55.55	56.80	56.80	55.55
24	56.56	54.58	56.66	54.87
25	55.79	56.89	48.59	50.80
	$\overline{X}$ = 54.30	$\overline{X}$ = 54.43	$\overline{X}$ = 52.92	$\overline{X}$ = 53.45

TABLE XXVI

PRINTING SHARPNESS VALUES PRINT FROM POLYOX FOUNTAIN SOLUTION, pH 4.00/B.T. 35 M, AT BOTH HIGH INK FILM THICKNESS (1.25 ± .05) AND LOW INK FILM THICKNESS (0.95 ± .05)

Sample	High ink film thickness 1st run	2nd run	Low ink film thickness 1st run	2nd run
1	50.52	51.62	54.29	53.33
2	52.50	53.00	53.06	55.90
3	50.00	52.90	60.00	59.00
4	53.16	52.89	50.71	52.80
5	55.85	54.76	48.71	49.00
6	54.55	53.95	44.44	45.90
7	59.50	58.80	57.14	55.80
8	56.76	54.70	59.72	57.80
9	53.40	56.89	47.37	49.86
10	58.22	59.85	53.85	55.78
11	56.00	55.82	55.95	53.90
12	52.08	58.90	56.94	55.81
13	57.97	53.70	55.42	57.78
14	53.65	56.93	53.57	51.81
15	50.55	53.95	52.38	52.30
16	52.17	51.76	53.41	53.56
17	51.85	53.86	53.71	54.86
18	53.49	52.97	51.25	52.30
19	54.88	55.67	55.45	54.70
20	53.41	52.76	51.85	52.60
21	55.81	56.80	50.63	50.94
22	52.56	51.95	55.88	54.90
23	54.43	55.78	54.12	55.97
24	52.38	51.40	54.22	53.70
25	53.80	54.56	55.29	56.80
	$\bar{X}$ = 53.98	$\bar{X}$ = 54.51	$\bar{X}$ = 53.57	$\bar{X}$ = 53.88

E. RESOLUTION

Resolution is the ability to produce the fine detail of an image. The Standard USAF 1951 Target was used for the resolution test. The target was made up of a series of groups decreasing in size. Each group is made up of three equal bars separated by spaces of equal width. Each bar is five times as long as its width.

The test was run two times per high and low ink film thickness. The density was 1.25 ± .05 for high ink film thickness and 0.98 ± .05 for low ink film thickness.

The best test materials were selected and 25 samples per high and low ink film thickness were taken for evaluation. The test objects consist of 5 groups and each group has 6 elements. Using a magnifying glass, and looking at each group to determine when one can not see the 3 bars separately will determine the resolution power of that particular sample. Once the resolution power is determined, note which group and element the resolution power falls in. The figures were obtained by looking through the Resolving Power Test Target Chart.[9] For example, in group number 5, element number 1, the resolution power is 32.00 according to the Resolving Power Test Target Chart. The larger the number, the better the resolution.

The collected data are shown in Tables XXVII to XXVIII. (pages 50-51)

TABLE XXVII

RESOLUTION VALUES PRINT FROM STANDARD FOUNTAIN SOLUTION AT BOTH HIGH INK FILM THICKNESS (1.25 ± .05) AND LOW INK FILM THICKNESS (0.95 ± .05)

Sample	High ink film thickness 1st run	High ink film thickness 2nd run	Low ink film thickness 1st run	Low ink film thickness 2nd run
1	36.0	28.5	40.3	45.3
2	28.5	32.0	40.3	50.8
3	32.0	36.0	45.3	40.3
4	40.3	40.3	50.8	57.3
5	36.0	28.5	57.0	40.3
6	28.5	36.0	36.0	57.3
7	32.0	40.0	36.0	36.0
8	32.0	36.0	45.3	45.3
9	40.0	32.0	50.8	36.0
10	36.0	40.3	36.0	40.0
11	28.5	28.5	40.3	50.8
12	28.5	40.0	50.8	57.8
13	32.0	25.3	57.8	40.3
14	32.0	32.0	40.3	45.3
15	40.0	32.0	45.3	40.3
16	25.3	40.0	36.0	45.3
17	36.0	36.0	45.3	57.3
18	40.0	25.3	40.3	36.3
19	25.3	28.5	36.3	50.8
20	32.0	32.0	36.3	50.8
21	28.5	32.0	50.8	57.0
22	36.0	36.0	45.3	50.8
23	32.0	28.5	50.8	50.8
24	28.5	36.0	57.0	50.8
25	36.0	32.0	45.3	45.3
	$\overline{X} = 32.88$	$\overline{X} = 33.49$	$\overline{X} = 44.63$	$\overline{X} = 46.51$

TABLE XXVIII

RESOLUTION VALUES PRINT FROM POLYOX FOUNTAIN SOLUTION, pH 4.00/ B.T. 35 M, AT BOTH HIGH INK FILM THICKNESS (1.25 ± .05) AND LOW INK FILM THICKNESS (0.95 ± .05)

Sample	High ink film thickness		Low ink film thickness	
	1st run	2nd run	1st run	2nd run
1	25.4	22.6	28.5	32.0
2	22.6	28.5	28.5	28.5
3	28.5	28.5	25.4	25.5
4	20.1	28.5	22.6	2–.6
5	17.9	22.6	20.1	28.5
6	22.6	25.4	25.4	32.0
7	22.6	17.9	25.4	25.4
8	16.0	22.6	22.6	28.6
9	28.5	22.6	28.5	22.6
10	20.1	28.5	28.5	28.6
11	25.4	20.1	25.4	32.0
12	25.4	25.4	32.0	25.4
13	20.1	28.5	28.5	32.0
14	28.5	25.4	22.6	28.5
15	22.6	28.5	25.4	25.4
16	20.1	20.1	32.0	20.1
17	22.6	28.5	20.1	25.4
18	20.1	22.6	20.1	28.5
19	25.4	25.4	25.4	28.5
20	22.6	20.1	32.0	32.0
21	20.1	22.6	28.5	28.5
22	20.1	25.4	22.6	25.4
23	22.1	20.1	28.5	25.4
24	25.4	22.6	25.4	32.0
25	25.4	22.6	28.5	32.0
	$\overline{X}$ = 23.15	$\overline{X}$ = 24.12	$\overline{X}$ = 26.11	$\overline{X}$ = 27.62

FOOTNOTES FOR CHAPTER III

[1]RBP Chemical Corporation, Milwaukee, Wisconsin

[2]Photovolt, 1115 Broadway, New York City, N. Y.

[3]"Solutions to Sticky Problems", (Massachusetts: Brookfield Engineering Laboratories, Inc.), p. 9.

[4]Brookfield Engineering Laboratories, Inc.

[5]"Instructions for the Use of No. 4063 Surface Tension Frame", (Chicago: W. H. Welch Scientific Company), p. 1.

[6]Erwin Jaffe, "Molecular Force Effects in Liquid", The Science of Physics in Lithography, (Pittsburgh: GATF, 1967), p. 11

[7]Division of American Hoechst Corporation, Murray Hills, N. J.

[8]Charles W. Latham, Advanced Pressmanship, (Pittsburgh: GATF, Inc., 1965), pp. 243 - 247.

[9]Itek Optical System Division, "Resolving Power Test Target Chart".

CHAPTER IV

CONCLUSION AND RECOMMENDATION

This research investigated the effects of Polyox in the fountain solution compared to the standard fountain solution. Polyox is a polymer of ethylene oxide and is a water soluble resin. Polyox fountain solution used throughout the test was made by dissolving 2 grams of Polyox in 400 cc water. Using phosporic acid to change the pH of the solution, tests were made of solutions with pH ranging from 3.00 to 5.00. Effects of blending was also tested with varying blending time of 15 to 35 minutes. Standard fountain solution used for comparison was 2 ounces of RBP Polyonic Fountain Concentration mixed with one gallon of water.

The physical properties such as viscosity, surface tension and contact angle were tested.

The viscosity was measured by Brookfield Synchro-Lectric Viscometer. The viscosity of Polyox decreased as the rate of blending time increased up to the point of pH 4.00. When the acidity was lower, the viscosity kept changing with each blending time. There was no set pattern to the changes (see Table I, on page 18). In the standard fountain solution, the viscosity increased as the concentration increased. (See Table II on page 18)

The surface tension was measured by Jolly Balancer. No significant differences between Polyox and standard fountain solutions were found.

The contact angle was measured by a photographic technique. The contact angle of Polyox decreases as the blending time increases, while the contact angle of standard fountain solution decreases as the concentration increases.

The press performances examined were roll up, ability to clean the plate, resistance to scumming, printing sharpness and resolution. There were five runs for each test. The press performances were under controlled press conditions such as type of paper, plate, ink and blanket.

In the test for roll up with the standard fountain solution, it took an average of 1.40 sheets in the five runs to get a good image. Polyox solution with the pH of 4.00 and blending time of 35 minutes only took an average of 1.20 sheets to obtain good image. (see pages 37-39)

Test for the ability to clean up the plate noted how many sheets it takes to obtain clean prints. The average sheets with the usage of standard fountain solution was 17.20 and Polyox with pH 4.00/B.T. 35 minutes it was 18.40 (see pages 40-42)

Test for resistance to scumming examined the amount of sheets each solution can print without scumming. The average with standard fountain solution was 4.80. Polyox the highest was 6.40

with pH 3.00/B.T. 15 minutes and lowest was 4.00 with pH 4.00/B.T. 35 minutes. (see pages 44-45)

For printing sharpness the measurement was taken using the densitometer. The test was run two times per high and low ink film thickness. The solid density was 1.25 $\pm$ .05 for high ink film thickness and 0.95 $\pm$ .05 for low ink film thickness. Twenty-five samples per high and low ink film thickness were taken for evaluation. The results were with standard fountain solution for high ink film thickness first run $\bar{X}$ 54.30, second run $\bar{X}$ 54.43. Low ink film thickness first run $\bar{X}$ 52.92, second run $\bar{X}$ 53.45. Polyox with high ink film thickness first run $\bar{X}$ 53.98, second run $\bar{X}$ 54.51. Low ink film thickness first run $\bar{X}$ 53.57, second run $\bar{X}$ 53.88.

Resolution examined the ability to produce fine details of an image. Twenty-five samples were selected per high and low film thickness from the two runs. The average is as shown below. The standard fountain solution at high ink film thickness first run $\bar{X}$ 32.88 and second run $\bar{X}$ 33.49. Low ink film thickness first run $\bar{X}$ 44.64 and second run $\bar{X}$ 46.51. Polyox fountain solution at high ink film thickness first run $\bar{X}$ 23.13 and second run $\bar{X}$ 24.12. Low ink film thickness first run $\bar{X}$ 26.11 and second run $\bar{X}$ 27.62.

The best results were obtained from Polyox fountain solution with pH 4.00 at 35 minutes blending time. The results showed that there are not many significant differences between standard fountain solution and Polyox fountain solution. Therefore, Polyox is as good as standard fountain solution. It is also proven that Polyox fountain solution keeps longer time than gum arabic used in standard fountain solution without bacterial attack.

RECOMMENDATIONS

Since Polyox fountain solution keeps longer time without bacterial attack, it will be interesting to conduct an experiment and tabulate the cost of using standard fountain solution vs Polyox to determine whether Polyox used instead of standard fountain solution would cut down production cost.

This experiment was on one type of plate, ink and paper. A study conducted with different types of plates, ink and paper would be helpful in determining the selection of material to be used.

The standard fountain solution used in this study contains ammonium bichromate. A study conducted to find out if addition of ammonium bichromate in Polyox improves it's properties would be interesting.

APPENDICES

APPENDIX A

CONTROLLED VARIABLES

1. Plate: Enco presensitized, type N-2. The exposure time was 1 1/2 minutes and developed according to the directions.
2. Paper: 8 1/2 x 11 inches, white Cascade, long grain, 20 lbs.
3. Ink: Litho Ink, IPI Speed King, Neutral Black (PMS)
4. pH: Varied between 3.00 to 5.00.
5. Press: ATF Chief 15. The press was adjusted according to the manufacturer's instructions.

APPENDIX B

TEST OBJECTS

1. Solid patches and tint patches of 133 line.

   The solid patches were used to control the density across the press sheet as well as to provide the printing sharpness datá.

2. GATF Sensitivity Guide, 21 steps of a continuous tone gray scale.

   This guide was used in order to give a uniform scale of light transmission for measuring plate exposure.

3. Slur target: A test image designed to show variations in the amount of slur along and across the press sheet.

4. GATF Star Target, a small circular pattern of solid and clear pie wedges. It provides a quick and effective measure of any ink spread, slur and doubling in the presswork.

5. GATF Dot Gain Scale: A visual device indicating dot area changes. It is made up of ten steps of 200 line screen tints which are graduated in density from step to step. These steps are in the form of numbers from 0 to 9 on a background of a 65 line tint of uniform strength.

6. The standard USAF 1951 Resolution Target: A series of patterns decreasing in size. Each pattern consists of three bars separated by spaces of equal width.

7. The halftone Gray Scale 12 step: 120, 133 and 150 lines.

BIBLIOGRAPHY

Adams, R. A. C., "Contact Angles and Their Significance in Lithographic Research", International Bulletin for the Printing and Allied Trades", (January 1956).

Banks, W. H., "A development in the Theory of Lithographic Fountain Solutions," Printing Trade Journal (July 1968).

Beechem, Henry A., "Contact Angles", Graphic Arts Monthly (December 1954).

Beechem, Henry A., "Offset Litho Chemistry", Graphic Arts Monthly (January 1954).

Bock, Ralph F., "A Study of Lithographic Fountain Solutions", Graphic Arts Technical Foundations, (Pittsburgh, PA: 1973).

Bock, Ralph F., "A Study of Lithographic Fountain Solutions", TAGA (1969).

Bruno, Michael H., "Dampening Lithography's Oldest Problems", Modern Lithography (October 1962).

Cummings, David, "Discovery and Application of Lithography", Handbook of Lithography, (London: McLagan and Cummings Ltd., 1932)

Division of American Hoechest Corporation, Murray Hills, New Jersey.

Hartsuch, Paul J., "Contact Angles and Plate Wettability", Chemistry of Lithography, (Pittsburgh, PA: Graphic Arts Technical Foundations, January 1963).

Hartsuch, Paul J., "Another Solution to Lithographic Dampening", Graphic Arts Monthly (July 1965).

W. H. Welch Scientific Company, Chicago, Illinois, "Instructions for the Use of No. 4063 Surface Tension Frame."

Itek Optical System Division, "Resolving Power Test Target Chart."

Kirk-Othmer, Encyclopedia of Chemical Technology, Vol. 8, 2nd Edition, (New York: John Wiley and Sons, Inc., 1966).

_______________ Vol. 10, 2nd Edition.

Latham, Charles W., Advanced Pressmanship, (Pittsburgh, PA: GATF, Inc., 1965).

Latham, Charles W., "Establishing pH Control", American Printer (February 1954).

Materazzi, Albert R., "Lithographic Chemical Shortages", Part I, Graphic Arts Monthly (February 1974).

Makarium, Theodore, "Split-fountain Printing on an Offset Press", Inland Printer (November 1966).

Muller, J. W., "Gum as the Real Preparation", The Invention of Lithography, (New York: The Fuchs and Lang Manufacturing Company, 1911).

"Offset Lithography", A Graphic Arts Production Handbook: Pocket Pal, (New York: International Paper Company, 1973).

Offset Lithoplate Making: "Alcohol in Conventional Dampening", Graphic Arts Monthly (September 1972).

Olinghouse, Lane, "Alkaline-based Fountain Solutions", Modern Lithography (August 1973).

Olinghouse, Lane, "Gum Arabic Substitutes Can Reduce Printing Cost", In-Plant Printer (July/August 1975).

Olinghouse, Lane, "The pH Factor", Modern Lithography (November 1972).

Paterson, Robert, "How to Use pH in a Litho Shop", Canadian Printer and Publisher (September 1957).

Photovolt, 1115 Broadway, New York.

RBP Chemical Corporation, Milwaukee, Wisconsin.

Stewart, C., "Ink and Water Balance in the Machine", Litho Printer (August 1958).

Stewart, C., "Dampening Problems", Litho Printer (June 1960)

Shaw, Victor J., "pH and What It Means to the Offset Pressman", Inland Printer (July 1966).

Watson, Charles E., "Bareback Dampening System", Printing Magazine (May 1965).

Whitworth, R. E., "Controlling the pH Factor in Litho Pressroom", Litho Printer, Vol. 10, No. 11, (November 1967).

Yoecheim, William E., "pH: Don't Run It Down", National Lithography (February 1961).

Yoecheim, William E., "New Trends Cause Problems", National Lithography (May 1961).