



Western Michigan University
ScholarWorks at WMU

Paper Engineering Senior Theses

Chemical and Paper Engineering

6-1959

Study of Some Factors Which Influence Froth Flotation of Deinked Stock

Peter C. Longjohn
Western Michigan University

Follow this and additional works at: <https://scholarworks.wmich.edu/engineer-senior-theses>



Part of the Wood Science and Pulp, Paper Technology Commons

Recommended Citation

Longjohn, Peter C., "Study of Some Factors Which Influence Froth Flotation of Deinked Stock" (1959).
Paper Engineering Senior Theses. 371.
<https://scholarworks.wmich.edu/engineer-senior-theses/371>

This Dissertation/Thesis is brought to you for free and open access by the Chemical and Paper Engineering at ScholarWorks at WMU. It has been accepted for inclusion in Paper Engineering Senior Theses by an authorized administrator of ScholarWorks at WMU. For more information, please contact wmu-scholarworks@wmich.edu.



STUDY OF SOME FACTORS
WHICH INFLUENCE FROTH
FLOTATION OF DEINKED STOCK |

Submitted June 10, 1959
By: Peter C. Longjohn

TABLE OF CONTENTS

Contents

LITERATURE SURVEY - - - - -	1
Introduction - - - - -	1
General Discussion of Flotation - - - - -	1
Flotation Agents - - - - -	2
Frothers - - - - -	2
Mechanism of Frothing - - - - -	2
Collectors - - - - -	3
Mechanism of Collecting - - - - -	4
Modifiers - - - - -	5
Bubble Mineral Attachment - - - - -	6
Deinking with the Froth Flotation Process - - - - -	7
EXPERIMENTAL DESIGN - - - - -	11
Objective - - - - -	11
General Summary of Experimental Work - - - - -	11
Discussion of Experimental Work - - - - -	11
Determination of a Suitable Cooking Formula - - - - -	11
Study of Variation in Amounts of Flotation Reagents - - - - -	14
Comparison of Two High Brightness Systems - - - - -	15
Bleaching of High Brightness Yields - - - - -	16
EXPERIMENTAL RESULTS - - - - -	19
Results - - - - -	19
Discussion of Results - - - - -	25
Conclusions - - - - -	27

ABSTRACT

Mineral and fiber were concurrently reclaimed from coated waste stock with the froth flotation process. Percentages of ash and fiber reclaimed are included along with the brightness of the deinked stock.

A suitable cooking formula and two flotation systems were discovered which respond favorably to froth flotation and yield a relatively high brightness before bleaching.

LITERATURE SURVEY

INTRODUCTION

A relatively recent development in the paper industry has been the innovation of the froth flotation process to the separation of printing ink from deinked paper stock produced from waste paper. The purpose of this work is to concurrently conduct a study of the practical factors which influence the froth flotation of deinked coated book papers; and to attempt a separation of the ink particles without removing any appreciable amount of mineral coating or cellulose fiber.

GENERAL DISCUSSION OF FLOTATION

Froth flotation is the process of separating finely divided solid particles of different materials from each other in a water suspension by means of air bubbles.

In froth flotation the separation takes place in water in which the solid particles are suspended because some species of suspended solids adhere to gas bubbles which are generated or introduced into the suspension while other species of solids do not adhere.

The solids adhering to these air bubbles rise through the suspension to the surface where they are concentrated and removed as a froth.

FLOTATION AGENTS

The success of flotation has been in the development of reagents that dissociate in dilute solutions to yield polar and nonpolar ions. These flotation agents are generally classified in three groups: (a) frother, (b) collector, and (c) modifier.

Frothers

A frother is an organic compound, such as pine oil, cresylic acid, and aliphatic alcohols of 5-10 carbons, which possess a water loving polar group and a water repellent non-polar hydrocarbon group. Essentially frothers control the size characteristics and permanence of the air bubbles on which the selected particles are floated (1). They should produce a froth which has the volume, stability, and strength to fully support its load of minerals until they are removed from the flotation machine.

MECHANISM OF FROTHING (2)

Frothing can be traced directly to the dual character of frother molecules which have one water-avid and one water-repellent portion. Both these affinities are satisfied if the molecules occur at bubble walls with the polar, hydrated end adhering to the water phase and their nonpolar end away from it, so that frother molecules concentrate at the interface between the fluid phases of flotation systems. As a result of the addition of a

frother, the gas bubbles formed under the surface of a liquid are partly lined with a monomolecular layer of frother molecules. This lining allows bubbles to approach each other without coalescing. The effect produced by the addition of a frother is proportional to the amount of frother. However, a point is eventually reached where addition of frother results in a decrease in frothing action until finally a critical amount completely destroys it.

Frothers function by changing the surface tension of the liquid. They also serve a secondary purpose in providing a zone in which the unfloated mineral particles and pulp that has been mechanically entrapped will drain away from the flotation concentrate.

Collectors

The collectors like the frothers have both polar and nonpolar groups and are generally organic ions such as provided by organic salts, acids or bases; the effective ion consists of a hydrocarbon chain to which a reactive group (-SH or $\text{C} = \text{O}$) is covalently bonded (2). These heteropolar



compounds are classified either as anionic or cationic depending upon whether the absorbing ion is negatively or positively charged. Examples of anionic collectors are fatty acids, resin acids, soaps, xanthates, and dithio phosphates, while the most important cationic collector reagents are the

fatty amine reagents. The functions of the collector reagent is to promote affinity between mineral particles and air bubbles by formation of a water repellent coating on the surface of the mineral.

MECHANISM OF COLLECTING

It is generally accepted that collector ions are absorbed in the form of an oriented film, with the polar ends attached to the mineral and the nonpolar ends away from it (3). The absorbing ion is replacing hydrogen, hydroxyl, or other more strongly attached ions already at the waterwetted surface. This displaced ion may have been of the same kind as occurs within the particle affected, or it may have been of a different kind, previously absorbed by the particle (2). Since the sorption of collector is definitely controlled by chemical properties of the solid and the agent, it is to be expected that collection will occur at localized sites rather than indiscriminately (2).

If enough collector concentration is maintained no flotation and no contact angle are obtained (2). No contact angle is possible at high concentration because of excessive adsorption. It is believed that a second hydrocarbon layer is orientated oppositely to the first and thus resulting in the nonflotation condition (2). Since the reaction under consideration takes place at the surface of minerals, and

also since only a partial monomolecular layer is required to produce flotation in most cases, the quantity of dissolved ion necessary to effect the reaction is extremely small (3).

Modifiers

A modifier is sometimes necessary to cause the particles to be floated to accept the collector, or to cause the particles to be nonacceptable to the collector and thereby be left behind in the suspension (1). If other ions are present in solution, in addition to the hydrogen and hydroxyl ions, they exert profound effects on the attachments of collector ions to the mineral surfaces. Modifying agents may be classed in one of the following groups, according to their functions (5):

1. PH control
2. Depressant
3. Activator
4. Disperser or deflocculator
5. Protective colloid

Examples of PH control agents are lime and soda ash for alkaline flotation, and sulfuric acid for PH control on the acid side.

In addition to hydrogen and hydroxyl ions, other anions and cations are involved in either increasing or decreasing the collection of each mineral by a given collector. The effect of relatively minor changes in hydrogen and hydroxyl ion concentrations show that change from complete flotation

to complete nonflotation may be obtained with a change in PH of one unit. However in the actual flotation systems, a less sharp effect should be anticipated because of the occurrence of many sizes, of many mineral species, and of looked particles (2).

Depressants act on the unwanted fraction of the suspension to reduce the tendency or prevent attachment of the collecting ion the particle surface. Lime and sodium cyanide are examples of depressants which leave the surface of the unwanted portion sufficiently wetted and thus prevent their removal.

An activator is used when a mineral has been depressed, or is not normally floatable. It imparts a coating to the mineral and serves to bring about attachment of the collector to the particle.

Occasionally the suspension is of such a nature that the materials flocculate within the suspension and prevent efficient flotation. It then becomes necessary to apply deflocculators and dispersants and protective colloids to hold these materials in the dispersed state. Sodium silicate is generally used as the dispersant, while either starch, casein or glue is used to provide the protective colloid.

BUBBLE-MINERAL ATTACHMENT (4,5,6)

Once a solid particle has been prepared with a water-

repellent surface, it must be brought into contact with an air-water interface for a separation to be affected. The introduction of the air bubbles and the agitation of the suspension by mechanical means brings the particles into contact with the air bubbles. If the force of attachment of the particle to the air bubble is sufficient to resist the shearing force of gravitational and stripping force of pulp turbulence, the particle will rise to the surface of the suspension. The size and specific gravity of the mineral, the relative nonwettability of the mineral surface, and the turbulence and density of the pulp are all controlling factors. In general, mineral particles coarser than 300 microns are not recovered by froth flotation (3).

DEINKING WITH THE FROTH FLOTATION PROCESS

A search of the available literature revealed that only four articles (7,8,9,10) have been published pertaining to deinking with the froth flotation process. Although these articles elaborately explain froth flotation, they are conspicuously lacking in pertinent froth flotation data.

Deinking may be defined as the removal of ink from wastepaper and the restoration of the fiber (or fiber and mineral) for reuse. The ink constitutes the largest percentage by weight of troublesome nonfibrous material in waste paper. This amount has been estimated by O'Donaghue

(11) to be from $\frac{1}{2}$ to 1% in the case of printed book paper and to range from 1 to 7% with magazines.

There are two basic steps in the deinking process (12):

1. Loosening the ink and defibering the stock.
2. Removing the ink from the fiber and mineral.

The loosening of the ink and stock defibering operation occurs simultaneously during the cooking operation. An ideal deinking formula would include:

1. An alkali to saponify the varnish or vehicle of the printing ink and release the pigment in the ink.
2. A detergent to aid in the wetting of the pigment in the ink.
3. A dispersing agent to prevent agglomeration of the pigment particles after release from the paper.
4. An adsorption agent to bind the pigment and prevent redeposition on the fiber.

The separation of ink from the fiber is accomplished in froth flotation by diluting the pulp slurry to at least 1% and adding flotation reagents in only sufficient amounts to facilitate its removal (8).

The application of froth flotation to deinking of magazine and other filled stocks has been difficult because of a finely divided ink will absorb on the surface of the filler present. Jelks (10) states that proper preparation of the stock prior to flotation can completely solve this problem and provide a white filler. He also indicated that a proper size particle is necessary to effect an ideal flotation condition.

If the ink finish is removed from the paper and broken only sufficiently to get it off the paper there will be no adsorption by the filler as the very fine particles necessary to adsorb will not be liberated. This can be accomplished by first soaking the waste paper in a detergent solution sufficiently long enough to break the bond between the paper and ink. If the paper so treated is pulped sufficiently to be pumped and immediately floated it is found that a sheet of 63 to 66 G.E. brightness before bleaching can be produced easily using a magazine furnish (10).

LITERATURE CITED

- (1) Flotation and Hercules Flotation Agents. 1953 Edition, Hercules Powder Co., Wilmington, Delaware.
- (2) Gaudin, A.M., Flotation, Second Edition, McGraw-Hill Book Company, Inc., (1957).
- (3) Flotation. Encyclopedia of Chemical Technology 6:595-599. The Interscience Encyclopedia, Inc., New York.
- (4) Flotation. Thorpe's Dictionary of Applied Chemistry, Fourth Edition, Vol. V, Longmans, Green and Co., London, New York, Toronto.
- (5) Sutherland, K.L., Physical Chemistry of Flotation. ✓
Journal Physical and Colloid Chemistry, Vol. 52, 394-425 (1945).
- (6) Evans, L.F., Bubble-Mineral Attachment in Flotation. ✓
Ind. Eng. Chem. Vol. 46, No. 11:2420-4 (Nov., 1954).
- (7) Jelks, J.W., Deinking Paper Pulp by Flotation. Paper ✓
Mill News 75, No.28: 14-17 (July 12, 1952).
- (8) Jelks, J.W., Flotation Opens New Horizons in the Paper ✓
Industry. Paper Trade Journal 134, No. 17, 22, 24, 26 (April 25, 1952).
- (9) Jelks, J.W., Deinking by the Froth Flotation Process. ✓
TAPPI 37, No. 1: 149-50 A (Jan., 1954).
- (10) Jelks, J.W., Developments in Flotation Deinking of ✓
Waste Paper. TAPPI 37 No. 10: 176-8A (Oct., 1954).
- (11) O'Donaghue, R., Paper Industry 22, No. 9:911-916
(Dec., 1940).
- (12) Casey, J.F., Pulp and Paper Chemistry and Chemical
Technology, Vol. 1, Pages 220-23, Interscience Publishers, Inc., New York, (1952).

EXPERIMENTAL DESIGN

Objective

The study of some factors which influence froth flotation of deinked stock.

General Summary of Experimental Work

This investigation was divided into four main parts:

- I. Determination of a suitable cooking formula.
- II. Study of variation in amount of flotation reagents.
- III. Comparison of two high brightness systems.
- IV. Bleaching of high brightness yields.

Discussion of Experimental Work

This research was carried out with coated magazine stock (C+E News) which contained only black inks.

Since the literature survey did not reveal any data pertaining to a cooking formula applicable to froth flotation, the first part of this work was to determine a suitable cooking formula.

I. Determination of a suitable cooking formula.

A. Cooking chemicals

1. Sodium Carbonate
2. Water Glass (41.0 Baume)
3. Tetra Sodium Pyro Phosphate

B. A Series of cooks were made by varying the amounts of cooking chemicals.

1. Varying the amount of sodium carbonate while holding the amount of water glass and T.S.P.P. constant at 1 gram and 0.05 gram respectively.

Cooks

- a. 0.0 gram Sodium Carbonate
- b. 0.5 " " "
- c. 1.0 " " "
- d. 1.5 " " "
- e. 2.0 " " "
- f. 2.5 " " "
- g. 4.0 " " "

2. Varying the amount of Water Glass while Sodium Carbonate (determined #1) and T.S.P.P. were respectively 0.5 and 0.05 grams.

Cooks

- a. 0.0 gram Water Glass
- b. 1.0 " " "
- c. 2.0 " " "
- d. 4.0 " " "

3. Varying the amount of T.S.P.P. while holding Sodium Carbonate (determined #1) at 0.5 gram and Water Glass (determined #2) at 1 gram.

Cooks

- a. 0.000 gram T.S.P.P.
- b. 0.0125 " "
- c. 0.05 " "
- d. 0.10 " "

4. 100 grams of A.D. coated paper (torn into pieces) were used in each cook.
5. Chemicals were weighed out and dissolved in 50 degree centigrade distilled water and diluted to two liters.
6. The cook was carried out by adding the stock (4) into a stainless steel pail containing solution (3) and defibering with an Atlas Disintegrator.
7. The temperature of each cook was initially

50 degrees centigrade.

8. Cooking time was thirty minutes.
9. After determining the amount of cooking chemicals (#1, 2, 3) a double batch was cooked using 200 grams of stock in two liters of solution containing doubled amount of chemicals. The cooking time was increased to forty-five minutes.

C. Froth Flotation of Cooks

1. Two 25 gram samples of each cook were diluted to 2.5 liters and then poured into the flotation cell. Two flotations were made per cook.
2. Flotation Reagents
 - a. 0.2 ml. Pine Oil (Yarmor F Sp.G.O.9370)
 - b. 0.1 ml. Triton X-10 (diluted 1 to 20)
 - c. 0.1 ml. Fuel oil (#2)
3. Temperature was 26 degrees centigrade.
4. Consistency was one percent.
5. Flotation time was ten minutes.

D. Evaluation of Cooks

1. The suspension left in the cell was collected on a filter pad in a Buckner funnel. The TAPPI Method for making brightness handsheets was then followed.
2. The brightness handsheets were then tested with the I.P.C. Brightness Tester after four hours of conditioning at constant humidity.
3. A brightness control sheet was made from each cook.
4. The percent increase in brightness was used as measurement of ink removal.

II. Study of variation in amount of flotation reagents. (Using standard cooking formula)

- A. The amount of Pine Oil was held constant at 0.2 ml. in all experiments. The temperature was 26 degrees centigrade, consistency was one percent, and flotation time was five minutes.
- B. A series of flotations were made by varying the amounts of Triton X-100 and Fuel Oil.

Flotations

1. Triton X-100 held constant at 0.0 milliliters.
 - a. 0.0 ml. Fuel Oil
 - b. 0.1 ml. " "
 - c. 0.8 ml. " "
2. Triton X-100 held constant at 0.1 milliliters.
 - a. 0.0 ml. Fuel Oil
 - b. 0.1 ml. " "
 - c. 0.2 ml. " "
 - d. 0.4 ml. " "
 - e. 0.8 ml. " "
3. Triton X-100 held constant at 0.2 milliliters.
 - a. 0.0 ml. Fuel Oil
 - b. 0.1 ml. " "
 - c. 0.2 ml. " "
 - d. 0.4 ml. " "
 - e. 0.8 ml. " "
4. Triton X-100 held constant at 0.4 milliliters.
 - a. 0.0 ml. Fuel Oil
 - b. 0.1 ml. " "
 - c. 0.2 ml. " "
 - d. 0.4 ml. " "
 - e. 0.8 ml. " "
5. Triton X-100 held constant at 0.8 milliliters.

- a. 0.0 ml. Fuel Oil
- b. 0.1 ml. " "
- c. 0.2 ml. " "
- d. 0.4 ml. " "
- e. 0.8 ml. " "

C. Special systems.

- 1. Pine oil - 0 ml.
Fuel Oil - 0 ml.
Triton X-100 - 0 ml.
- 2. Pine Oil - 0.5 ml.
Fuel Oil - 0.5 ml.
Triton X-100 - 0.5 ml.
- 3. Pine Oil - 0.1 ml.
Fuel Oil - 0.1 ml.
Triton X-100 - 0.1 ml.

D. The same method of evaluation as outlined under (I-D) was used.

III. Comparison of Two High Brightness Systems.

These two systems were determined in part II. The standard cooking formula was used and the temperature was 23.5 degrees centigrade while the consistency was one per cent.

- A. System #1 using 0.2 ml. Pine Oil, 0.8 ml. Fuel Oil, and 0.8 ml. Triton X-100.
- B. System #2 using 0.1 ml. of each reagent.
- C. The comparison was made by collecting the floats from each system at the following flotation time intervals: $\frac{1}{2}$, 1, 2, 4, 8, and 16 minutes. These floats were then dried and weighed prior to ashing. The suspension left in the cell at each time interval was then made into a brightness handsheet. The percent of ash and brightness was used to compare the systems.
- D. The ash content of the original coated waste paper was determined.

E. Special Experiment

The purpose of this experiment is to determine the amount of float that can be recovered by reflation.

1. System (#2) was used with a flotation time of five minutes.
2. The collected float was reflatated for five additional minutes.
3. Brightness handsheets were made after each flotation.
4. The reflat was ashed.
5. The amount recovered and the percent ash were determined.

IV. Bleaching of High Brightness Yields. The brightness handsheets collected after 16 minutes flotation time were used.

A. Samples were weighed and disintegrated in a Waring Blendor.

B. Chlorination (using chlorine water)

1. 2% available chlorine
2. 3% consistency
3. 23 degrees centigrade
4. pH was 2.0 (adjusted with HCL)
5. Time was 60 minutes

C. Distilled water wash.

D. Sodium Hypochlorite Bleach

1. 0.5% available chlorine
2. 3% consistency
3. 23 degrees centigrade

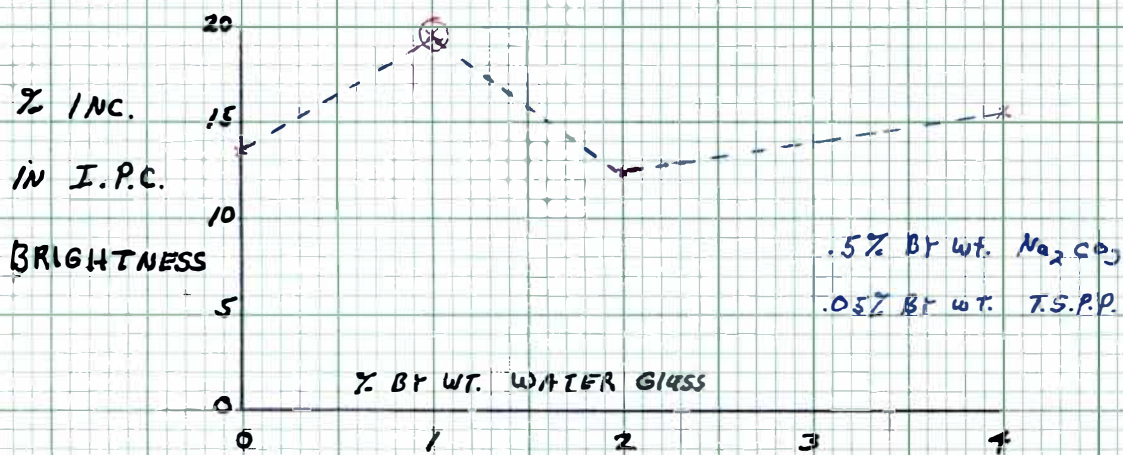
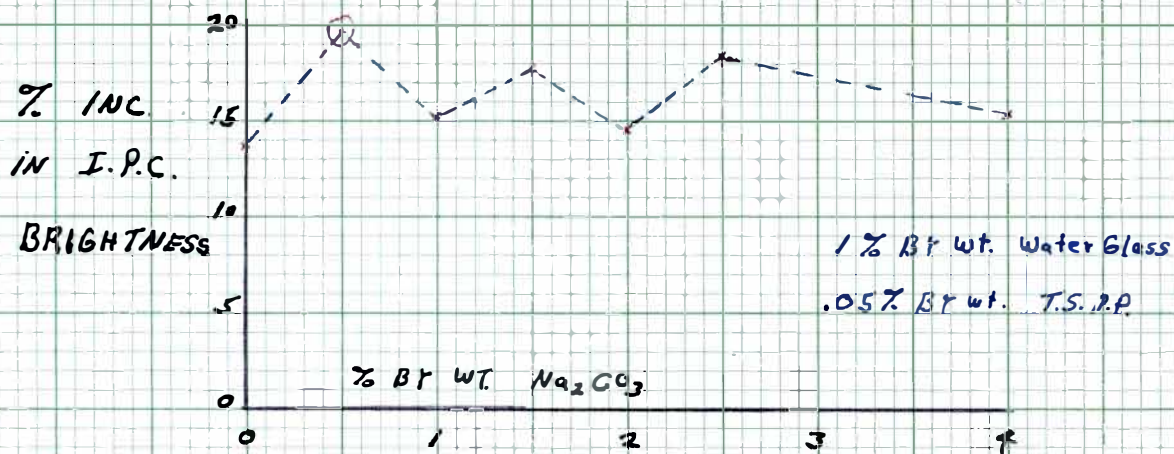
4. pH was 11 (adjusted with NaOH)

5. Time was 30 minutes.

E. Distilled water wash

F. Brightness handsheets were made and the brightness was determined after four hours of conditioning at constant humidity.

GRAPH ANALYSIS OF COOLTS

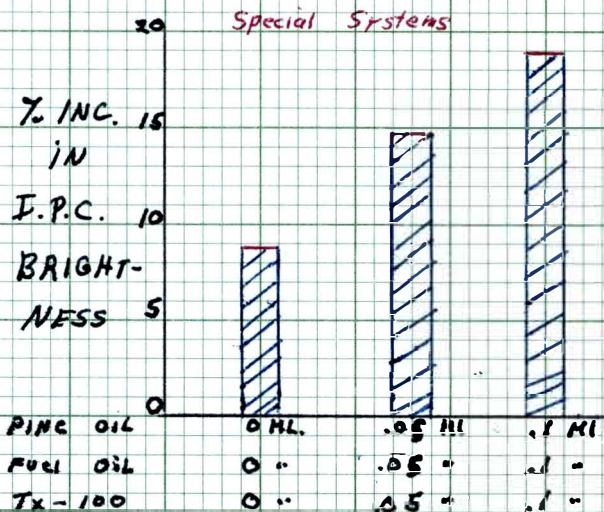
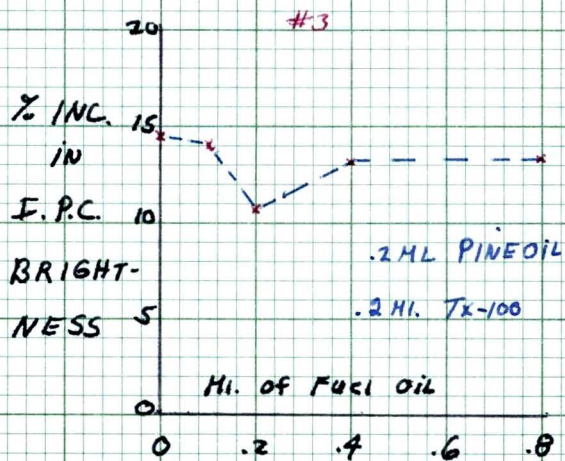
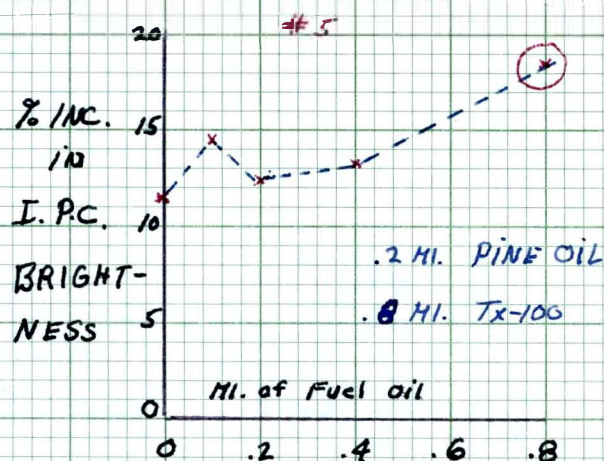
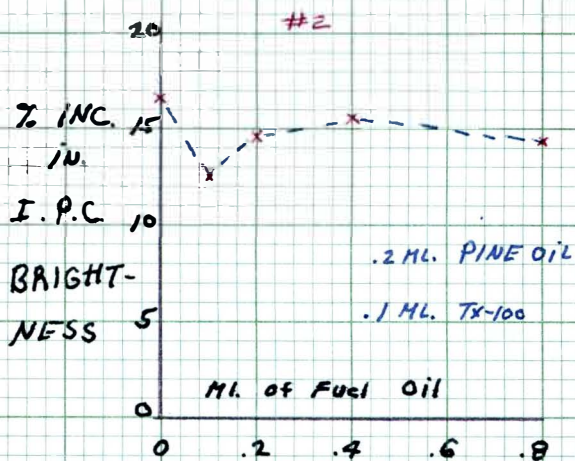
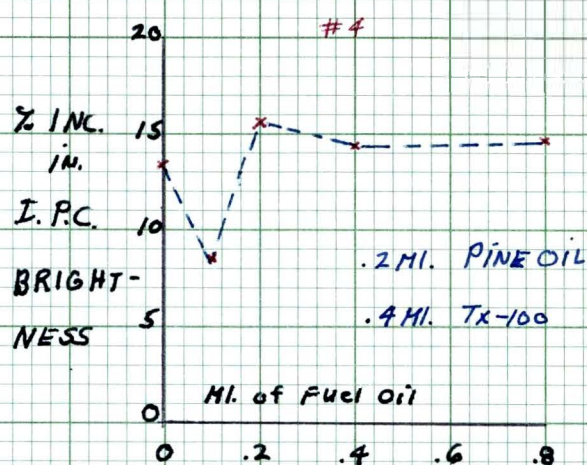
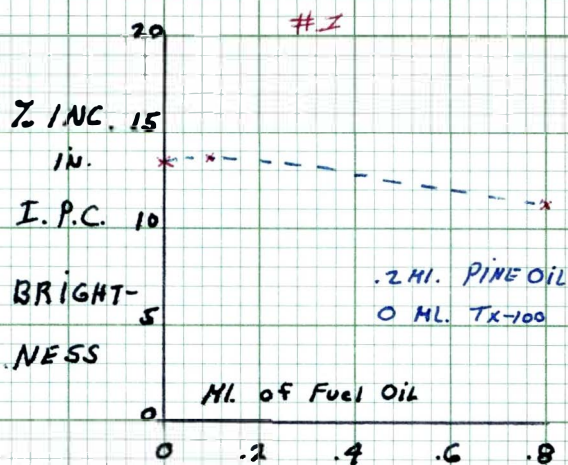


EXPERIMENTAL RESULTS

PART I. (Determination of a suitable cooking formula)

No.	Cooking Chemicals % by wt.			%Brightness Before Flotation	%Brightness After Flotation Avg. Two Samples	%Increase in I.P.C. Brightness
	Na ₂ CO ₃	WaterGlass	T.S.P.P.			
1-a	0.0	1.0	0.05	57.5	65.4	13.7
-b	0.5	"	"	56.2	67.21	19.7
-c	1.0	"	"	58.08	66.92	15.2
-d	1.5	"	"	55.93	65.9	17.8
-e	2.0	"	"	56.91	65.2	14.75
-f	2.5	"	"	56.16	66.48	18.4
-g	4.0	"	"	55.8	64.25	15.1
2-a	0.5	0.0	0.05	57.3	65.1	13.6
-b	"	1.0	"	56.2	67.3	19.7
-c	"	2.0	"	56.8	63.7	12.2
-d	"	4.0	"	56.9	65.9	15.8
3-a	0.5	1.0	0.0	56.1	63.8	13.7
-b	"	"	0.0125	57.1	66.43	16.3
-c	"	"	0.05	56.2	67.2	19.7
-d	"	"	0.1	56.9	66.2	16.3
Results of Double Batch						
9-	1.0	2.0	0.1	56.2	66.99	19.2

ANALYSIS OF VARYING THE AMOUNTS OF FLOTATION REAGENTS



PART II (Study of variation in amount of flotation reagents)

No.	Flotation Reagents in ml.			%Brightness Before Flotation	%Brightness After Flotation Avg. two samples	%Increase in I.P.C. Brightness
	Pine Oil	Fuel Oil	Triton X-100			
1-a	0.2	0.0	0.0	57.25	65.0	13.5
-b	"	0.1	"	57.25	65.1	13.7
-c	"	0.8	"	57.25	63.6	11.1
2-a	0.2	0.0	0.1	57.25	66.8	16.7
-b	0.2	0.1	"	57.9	65.3	12.8
-c	"	0.2	"	58.3	66.9	14.8
-d	"	0.4	"	57.9	66.9	15.5
-e	"	0.8	"	57.9	66.1	14.2
3-a	0.2	0.0	0.2	58.3	66.8	14.6
-b	"	0.1	"	58.3	65.7	14.0
-c	"	0.2	"	57.9	64.2	10.9
-d	"	0.4	"	57.9	65.5	13.1
-e	"	0.8	"	57.9	65.6	13.3
4-a	0.2	0.0	0.4	58.3	66.0	13.2
-b	"	0.1	"	58.3	63.3	8.6
-c	"	0.2	"	57.9	66.9	15.5
-d	"	0.4	"	57.9	66.2	14.3
-e	"	0.8	"	57.9	66.5	14.8
5-a	0.2	0.0	0.8	57.25	63.8	11.4
-b	"	0.1	"	58.3	66.9	14.8
-c	"	0.2	"	57.9	65.3	12.4
-d	"	0.4	"	57.9	65.5	13.1
-e	"	0.8	"	57.9	68.6	18.5
Special System						
1	0.0	0.0	0.0	57.25	62.25	8.7
2	0.5	0.5	0.5	57.0	65.4	14.7
3	0.1	0.1	0.1	57.0	67.7	18.8

PART III (COMPARISON OF TWO HIGH BRIGHTNESS SYSTEMS)

Flotation Time in Minutes	0	$\frac{1}{2}$	1	2	4	8	16
System # 1							
% of Original 25g. in Float	-	0.38	1.14	2.31	10.3	40.1	53.1
% of Float that is Ash	-	11.2	8.6	13.7	34.4	32.6	28.2
% of Total Ash in Float	-	0.13	0.3	0.95	10.7	39.5	46.0
Brightness of D.I. Stock	57.4	57.5	58.4	60.7	62.6	66.4	69.3
% of Total Ash in D.I. Stock	-	99.87	99.7	99.05	89.3	60.5	54.0
System # 2							
% of Original 25g. in Float	-	0.89	3.46	13.23	24.62	32.18	38.68
% of Float that is Ash	-	9.1	26.6	37.4	36.0	32.4	29.6
% of Total Ash in Float	-	0.24	2.8	14.9	26.8	31.4	34.5
Brightness of D.I. Stock	57.4	57.6	58.6	60.5	64.4	67.0	69.0
% of Total Ash in D.I. Stock	-	99.76	97.2	85.1	73.2	68.6	65.5

PART III (Special Experiment)
(E)

Brightness Before Flotation	-	57.0
Brightness After Flotation	-	67.7
Brightness After Reflotation of Float	-	64.0
Analysis of:	Float	Refloat
% of Original 25g. in Float	26.63	-
% of Original 25g. in Refloat	-	12.78
% of Float that is Ash	38.1	
% of Refloat that is Ash	-	16.5
% of Total Ash in Float	30.7	-
% of Total Ash of Float in Refloat	-	44.01
% of Total Ash in D.I. Stock	69.3	
% of Total Ash of Float in D.I. Stock		55.99

PART IV (Bleaching of high brightness yield)

	System # 1 16 minutes Handsheet	System # 2 16 minutes Handsheet
% Brightness Before Flotation	57.4	57.4
% Brightness After Flotation	69.3	69.0
% Increase in Brightness After Flotation	20.7	20.2
% Brightness After Bleaching	74.91	72.66
% Increase in Brightness After Bleaching	8.1	5.4

DISCUSSION OF RESULTS

- (1) The plotting of percent increase in brightness against percent by weight of cooking chemicals readily determined the optimum percentage by weight of each chemical. The standard cooking formula became:
 - (a) 0.5% by weight Na_2CO_3 on weight of A.D. stock
 - (b) 0.05% by weight T.S.P.P. on weight of A.D. stock
 - (c) 1.0% by weight Water glass on weight of A.D. stock
 - (d) Consistency of 10%
 - (e) Temperature at start was 50°C
 - (f) Time was 45 minutes
 - (g) PH was 9.2
- (2) Experiments in which the amounts of flotation reagents were varied revealed two flotation systems, (#1- .2, .8, .8 ml. and #2- .1, .1, .1 ml. respectively of pine oil, fuel oil, and triton X-100), that produced a brightness of 67-68% before bleaching while using the standard cooking formula.
- (3) Comparison of these two high brightness systems at definite time intervals revealed the following:
 - (a) The results from $\frac{1}{2}$ and 1 minute flotation times were not significant.
 - (b) After 2 minutes, both systems developed a 60 brightness.
 - (1) System # 1 retained 97% of the original stock and 99% of the total ash.
 - (2) System #2 retained 84% of the original stock and 85% of the total ash.
 - (c) After 4 minutes, system #1 had a 1.8 point higher brightness.
 - (1) System # 1 retained 89% of the original stock and 89% of the total ash.

(2) System # 2 retained 75% of the original stock and 73% of the total ash.

(d) After 8 minutes, both brightness values were similar and over 66.

(1) System # 1 retained 59% of the original stock and 60% of the total ash.

(2) System # 2 retained 67% of the original stock and 68% of the total ash.

(e) After 16 minutes, both brightnesses had gone up to 69.

(1) System # 1 retained 46% of the original stock and 54% of the total ash.

(2) System # 2 retained 61% of the original stock and 65% of the total ash.

(4) The refloatation of a collected float showed a 52% weight recovery and a 64 brightness on the D.I. stock. Also 56% of the total ash in the float was recovered in the reclaimed D. I. stock.

(5) Also in the flotation experiment, the first flotation retained 73.37% of the original stock and 69.3% of its total ash content. A refloatation of the float recovered an additional 12.78% of the original stock. The total recovery after two flotations was 86.15% of the original stock and 85.8% of the total ash content of the original stock.

(6) Bleaching with two stages (chlorination and hypochlorite) increased the brightness 8.1% for system # 1 and 5.4% for system # 2. The actual brightness value for system # 1 was 74.9 and 72.7 for system # 2.

CONCLUSIONS

- (1) The most beneficial, important, and significant finding in this investigation was that the mineral present in the original stock can be reclaimed concurrently with the fiber.
- (2) It was shown on page 22 that 69.3% of the total ash content can be recovered with one flotation and this can be increased to 86.15% with a refloatation of the float. Since the ash recovery was increased by a second flotation, it is assumed that a third and fourth flotation would also add to this recovery.
- (3) If an initial separation of the float and D. I. stock were made, and then a countercurrent system were arranged whereby the floats from a series of flotation cells were consecutively passed from one cell to the next; and the D. I. stock portion pumped back to the proceeding cell, a large percentage (greater than 86%) of the mineral in the original stock should be retained and a brightness greater than 65 I. P. C. should be produced before bleaching.
- (4) This process of reclaiming the mineral along with the fiber is advantages in two respects.
 - (a) It should make deinking more economical since the necessity of re-adding large quantities of new mineral back to the D. I. stock, as is presently being done by most deinking mills, will not be

necessary.

(b) It should reduce stream pollution.

- (5) Recovery of cooking chemicals is unnecessary in froth flotation because only sufficient alkali is needed to release the ink particles. In fact, the graph on page 18 shows that excess alkali is not justifiable since it increases the deinking cost and does not render a proportionate increase in brightness.