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The Effects of Using a Closed Water System in Deinking of Newspaper

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THE EFFECTS OF USING A CLOSED WATER SYSTEM IN DEINKING OF NEWSPAPER

BY

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ABSTRACT

In studying the effects of deinking newspaper using recycled water, I found that the degree of dissolved solids was extremely important. It was discovered that using fresh distilled water to deink with resulted in a 5% drop in brightness. A 25% drop would result if water having 6.5 grams/liter of dissolved solids was used to deink with. A higher amount of dissolved solids can be tolerated in the washing water then could be tolerated in the cooking liquior. The cooking liquior seems to be extremely sensitive to dissolved solids content of the water.

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INTRODUCTION

The first deinking process started back in 1695 by George Balthaser Illy of Denmark (1) . Since that time, recycling was only used occasionally when the rags to supply the papermaker were scare. The invention of the fourdrinier papermaking machine and the discovery of mechanical and chemical wood pulps in the latter half of the nineteenth century, killed the incentives for recycling (2).

Todays new incentives such as, industrial economics, national economics, and the environment, are forcing the papermakers to renew their interest in recycling (3) . In 1970, the U.S. recycled 21% of its' total production, while West Germany recycled 31%, Japan 38%, and Sweden 25% (3). In 1974 45% of all newsprint supplies in Britian were recycled waste paper (4). Germany in 1974 used recycled waste paper for 44% of its' raw material for papermaking (5). Mills in 1974 were able to produce a suitable clean recycled pulp at a cost of $190-$215/ton, while virgin pulp cost $350/ton (6).

There are vitial reasons for deinking waste paper over use of virgin pulp and they are as follows (7):

1. Conservation of virgin pulpwood.
2. Low cost of fibers produced by deinking.
3. Lower initial cost of deinking equipment verses the cost of virgin wood pulping equipment.
4. Turning a wste material into a useable material.

As an example of todays trend in industry's use of

recycled waste paper, the Georgia-Pacific Co. spent $5.8 million on a new floatation deinking unit at its' Kalamazoo, Michigan mill (8). For the G-P plant, virgin pulp cost $300-$325/ton while recycled pulp cost $140-250/ton. Also a 26% energy savings was gained by using deinked pulp.

WASHING VS FLOATATION

Deinking is a two step process. The first step is a chemical, thermal and mechanical action that disintegrates the waste paper. The detachment of the ink from the fibers is also accomplished in this first step. The second step is the seperation of the fibers form the ink particles and other undersirables. This can be achieved by either washing or floatation. Both methods have their advantages. Matze (9) explains most of them in his study and they are as follows:

ADVANTAGES

WASHING DEINKING	FLOATATION DEINKING
1. low investment cost - high production (150 TPD)	1. higher yield (85-95%) lower losses of fines and fillers
2. cheaper chemicals	2. lower water requirements ($10m^3/T$)
3. lower waste paper grades	3. simpler circuit closure
4. frequently continuous	4. lower waste water load (BOD 10 Kg/T)
5. extensive ash reduction	5. better utilization of chemicals in batch pulper is possible

DISADVANTAGES

1. lower yield (75-85%)	1. higher investment costs
2. higher fines and filler	2. lower production (max 100

DISADVANTAGES

WASHING DEINKING	FLOATATION DEINKING
loss	TPD per extraction)
3. higher water consumption (up to 160m^3/T)	3. more costly chemicals
4. more complicated circuit closure	4. only partial ash reduction
5. frequently after bleaching because of lower pulper consistency	5. usually somewhat better waste paper grades required

COOKING AND DEFIBERING

The cooking and defibering is accomplished in the pulper. The chemical action is necessary to saponify the ink base and perform other actions. The six basic chemical ingredients needed for repulping are as follows:

1. Alkalis
2. Detergents
3. Dispersing agents
4. Softening agents
5. Selective adsorptive agents
6. Miscellaneous chemicals

The cooking variables are as follows (10):

1. Type of chemicals(varies with the type of waste paper)
2. Quanity of chemicals used
3. Consistency of pulp
4. Pressure
5. Temperature
6. Degree of agitation
7. Time

ALKALIS

Reuben and Reynolds (11) in their study of alkali's effect upon deinking showed that the primary effect of the caustic treatment was to increase the cellulose fibers' swelling. The low alkali con centration normally used in deinking, 4 to 8%, (12) probably would cause mild degradation of the exposed cellulose fibers. An added benefit of the alkali is its' ability to saponify the binders used in the printing inks. It has been shown that there is an increase in whiteness of the deinked pulp as a function of the kind of alkali and the Ph value (12,13). In general the whiteness increases with the Ph till a limit is reached, depending on the waste paper, where a pronouched yellowing effect is caused. Usually a Ph of 9 to 10 is consirdered to be the best (12,13,14). A lower Ph value much below 8.5 results in poorer stock quality.

Sodium silicates (Na_2SiO_3) are bing used increasingly tosupplement caustic soda in the deinking field. The reason being that silicates provide better ink removal and brighter pulps with less fiber damage (12,15). Usually meta silicate is used instead of liquid silicate because less soda is needed (15). The difference between liquid silicate and meta silicate is their mole ratio of SiO_2 to Na_2O. The meta silicate has a one to one ratio while liquid silicate (water glass) has a 3.33 ratio. One reason given for the alkaline silicate's better performance over caustic soda is due to the emulsifing power of the silicate. Another reason becomes important when peroxide is used in the repulping process.

This being that silicates are a stabilizing agent for peroxide preventing its' decomposition.

DETERGENTS

These surface-active chemicals are very important in improving the detachment of printing inks which have been already saponified. Of all the types available, the non-ionic have been proved the most efficient (12,16). Turia and Williams (16) in their study have characterized various surface-active agents by their hydrophilic-lipophilic balance (HLB) and labeled this in a scale from 0 to 20. The more hydrophilic an emulsifier, the higher the HLB number. They have shown that the optimun HLB value for a non-ionic detergent for deinkingis in the 14.5 to 15.5 range. They list Rohm and Haas' Triton CF-10 as the best non-ionic detergent for deinking. Diamond Shamocks' Hyponic PE-120 is also listed as an efficient detergent. The importance of the pulping temperature is also mentioned. They state that the temperature should be as low as possible without exceeding the cloud point of the detergent.

Bechstein (12) also states that non-ionic detergents worked better than either cationic or anionic ones. The slightly ethyoxylated nonylphenols were excellent in removing impurities and the printing ink particiles. For use in a floatation cell a concentration of 0.1 to 0.2% was recommended.

TYPES OF CHEMICALS USED IN DEINKING

Caustic soda is probably the cheapest chemical used, but its' performance is not adequate enought to offset its' cost. Most studys have shown a combination of sodium peroxide (Na_2O_2), sodium silicate (Na_2SiO_3) and a surface-active agent (6,15,16,17,18,19,20) give the best brightness. The sodium peroxide is used in varying concentrations, 1.0 to 2.0%, to help saponify the ink binder and supply the needed alkali. Care must be taken when using a peroxide with un-deionized water because certain metal ions (Fe^{+3},Cu^{+2},Mn^{+2}) will decompose it (12). Magnesium salts and silicates are helpful in preventing this decomposition from happening.

Sodium silicates are added from 2.0 to 16%. This is usually the 3.33 molar ratio of the SiO_2 to Na_2O, known as water glass, with a solids level of 38% (15).

The type of surface-active agent varies but most studies recommend a non-ionic one in the 0.2 to 1.0% addition level.

CONSISTENCY, DEGREE OF AGITATION AND TIME

Time, consistency and the degree of agitation are all interrelated when considered in the repulping phase of de-inking. The average time in industry for pulping is 30 min. (8,15,21) and then a soaking time of 30 min. to 2 hrs. (8,14,21,22). The degree of agitation depends on the waste paper and the equipment, but care must be taken not to reduce the ink particles to too small a size if floatation is to be used. Bechstein (12) found that ink particles smaller then 5 um are difficult to float out. The consistency varies from low density of 5 to 8% to high density of 20 to 40% (23). The average consistency for industry seems to be in the 5 to 8% range (6,8,14,21).

TEMPERATURE

The temperature used is affected tremendously by the type of waste paper being recycled (11,23). High groundwood papers defiber and deink better as the temperature is decreased. The temperature range of 100°F to 160°F is normally used.

A CLOSED WATER SYSTEM FOR DEINKING

Cruea (25) in his study of a closed water deinking system found results which demostrated that it was not the amount as much as the nature of the solubilized materials that influences the deinking ability of the water. He found that alum-treated water dropped the resulting deinked pulp 17% in brightness compared to distilled water. It was also discovered that a multiple Ph change would also reduce the brightness of the deinked pulp.

A study by Matthew (26) found that when an ink dispersion system using a surfactant for deinking was used, a buildup of hardness ions lowered the pulp brightness. Specificly, the calcium and magnesium ions seemed to be the most important. It was also found out that contrary to previous belief, dispersed ink could pass through a 8-um filter, thus proving that high consistency washing could be used. In his study the water consumption was reduced from 20,000 gal/ton to 5,000 gal/ton. The only problem with his results was that he was required to use as ion-exchange softening process on his recycled water to obtain a 54% deinked pulp brightness.

DISCUSSION OF PARAMETERS

The experiment was divided into seven runs (A to F). During each run, usually one parameter was allowed to vary while the other parameters were held constant. The parameters that were varied during this experiment were as follows:

1. The water used for the pulp washing.
2. The water used for the pulp cooking.
3. The chemicals used for the cooking.

The parameters that were held constant throughout the experiment were as follows:

1. The cooking temperature (50° C).
2. The cooking time (30 min.).
3. The washing and cooking techniques and equipment.
4. The newspaper used (Kalamazoo Gazette).

Each run was further divided into six or seven parts(I to VI or VII). Each part consisted of different cooks or different washing procedures.

RUN A

This run was primarily a control run done to compare with the recycled water runs(B & C). It consisted of six cooks(I-VI). It was done according to flow diagram #1 (see figure #1, p. 26). No experimental parameters were varied in this run. Each part of the run(I-VI), consisted of a seperate cook and washing stage. The cooking chemicals(see Table #3, p. 35) were the same for the whole run. Tap water was used throughout this run in both the cooks and the washings. The water useage for this run was 48,300 gal/ton.

RUN B

This run was the first run to use recycled water for both the cooking and the washing. It was done according to flow diagram #2(see figure #2, p. 27). The laboratory floatation cell(see photograph #6, p. 40) was used to clean the used cooking and washing water up. Fresh tap water was only added to the floatation cell as needed. The cooking chemicals(see Table #3, p. 35) were varied slightly, not as an experimental parameter, but to try and keep the total alkali (TA) the same for each cook. The experimental parameter varied in this run was the recycled water used. The water useage for this run was 3,000 gal/ton. This represents a 94% closure of the water system compared to run A.

RUN C

This run was the second recycled water run. It was also done according to flow diagram #2(see figure #2, p. 27). This run was similar to run B, with the recycled water as the experimental parameter. This run differed from run B in that only five cooks were made. The last cook, after it had been run through the second Side Hill washing, was divided into two halfs. One half(V) was treated like the other parts of the run and made onto pads. The other half(VI) was washed twice more in the Side Hill washer using fresh tap water each time for dilution. The water useage for parts(I to V) was the same as for run B, 3,000 gal./ton. Part VI used 62,800 gal./ton, which represents an 2000% increase in water useage over the other parts of run C(Ito V).

RUN D

This run followed flow diagram #1(see figure #1, p.26). In this run I used different cooking chemicals as the expreimental parameter. Instead of having one experimental parameter, there were two. The other experimental parameter was the water used for washing. Three different cooking chemical combinations were used(see Table #3, p. 35). After the pulp centrifuge, each cook was split in half. One half was washed with distilled water and the other half was washed with distilled water with NaCL added ot it. There was enough NaCL added to obtain a 0.9 gram/liter. The parts of this run that were washed with just distilled water were I,III and V. Parts II,IV and VI were washed with the salt water. All the cooks were done using distilled water. The water useage for all the parts was 48,300 gal./ton.

RUN E

This run was done using different amounts of NaCL in the wash water as the experimental parameter to simulate dissolved solids. Two cooks were made using 225 grams(O.D) of newspaper each. After the pulp centrifuge, each cook was split up into three equal parts. Each part(I to VI) became a seperate washing procedure. The chemicals for both the cooks(see Table #3, p.35) were the same. Distilled water was used for the cooks and tap water with varying amounts of salt added to it was used for the washing water. The amount of salt added to the washing water was as follows:

RUN E

PART #	NaCL(grams/liter)
I	0
II	1
III	2
IV	3
V	6
VI	9

RUN F

This run was done using varying amounts of NaCL in the cooking liquior as the experimental parameter. Each part of the run(I to VII), consisted of a seperate cook and washing stage done according to flow diagram #1(see figure #1, p. 26). The cooking chemicals for all the parts of the run were the same(see Table #3,p. 35), but different amounts of NaCL were added as follows:

PART #	NaCL(grams/liter)
I	0
II	1
III	2
IV	3
V	4
VI	5
VII	6.5

RUN F

Distilled water was used for all the cooks and tap water was used for all the washings. The only exception was part VII. This part used distilled water for the cook, but the tap water used for the washing had 6.5 grams/liter of NaCL added to it.

COOKING OUTLINE

I. Cooking

A. To the 7 liter metal cooking beaker(see photo #1,p.38), 132 grams(O.D.) of newspaper were added.

B. The cooking chemicals(see Table #3,p.35) and 3.6 liters of hot water were added to the beaker.

C. The newspaper was allowed to soak for 5 min.

D. The disintegrator(see photo #8,p. 41) was turned on for 5 min. at full speed.

E. The disintegrator after 5 min. at high speed, was slowed down to the 50# mark on the reostat and held at this speed for 25 min.

WASHING OUTLINE

I. Washing

A. The pulp from the cooking beaker was placed in a nylon bag and put into the pulp centrifuge(see photo #2,p.38). The centrifuge was then run for 3 min.

B. Pulp from the centrifuge (at approx. 25% cons.) was diluted to 1% cons. with 13 liters of water obtained from the previous 2nd Side Hill washing. This diluted pilp was then stirred with the disintegrator at slow speed for 3 min.

C. Pulp was then run down the Side Hill screen(see photo #3,p.39) twice to obtain an approximate 4% cons. pulp.

D. The pulp was then diluted back to 1% cons. with 10 liters of water and run down the Side Hill screen again.

E. The dirty water from the 2nd Side Hill wash was saved to dilute the next pulp from the pulp centrifuge.

F. The 4% cons. pulp from the 2nd Side Hill wash was then diluted with 13 liters of water to 0.8% cons. This pulp was then made into 6 inch circular pads. This was done using 6 inch circular screens made from old paper machine plastic wire and a Büchner funnel (see photo #4,p.39)

G. The pads were then run through a wet press(see photo #5,p.40) and twice through a steam dryer(see photo #7,p.41)

I. The pads were then allowed to air dry for 3 days.

BRIGHTNESS TEST OUTLINE

I. Brightness Test

A. After 3 days of air drying, the brightness of the pads was taken using the Martin-Sweet Brightness meter.

B. Each pad had 5 brightness readings taken on it.

C. The results of the brightness tests are listed in Table 1,p.32. Each value listed is an average of 50 to 30 values(5 values per pad and 10 to 6 pads per part of the run).

D. Color analysis was done on the pads using the Technidyne Model S-4 Brightness and Colorimeter. The results are in Table #4,p.36.

WATER TESTS OUTLINE

I. WATER TESTS

A. During all the runs,(A to F) a sample of the used cooking liquior, after it came out of the pulp centrifuge, was tested. It was tested for total alkali(TA), total dissolved solids(TDS), Ph and Conductance.

B. The TA was tested by titrating a 100 ml sample of the used cooking liquior with a 0.1N HCL solution.

C. The TDS was measured by placing 20 ml of used cooking liquior, after it had been filtered through filter paper, into a pre-weighted aluminium disposable pan. After drying in an oven at 105 C for 2 days, the pan was weighted and a value for the TDS calculated.

D. The Ph was measured on a Ph meter.

E. The Conductance was measured with a Wein-Bridge type of meter.

RESULTS

RUN A

This run showed an approximate 6.5% drop in brightness from the original newspaper. The color analysis didn't show much variation(low 573 nM, high 578 nM). A human eye evaluation showed more variation then the colormeter did.

The used cooking liquior analysis gave some interesting aspects. The conductance of the used cooking liquior dropped 25% from that of the original cooking liquior. This I felt was due to some of the caustic being used up. The TA of the used liquior dropped 30.4% from that of the new liquior. The TDS increased 19.9% over the original liquior.

RUN B

The brightness dropped 12.5% for the first recycled cooks. After the second cook, the dissolved solids in the recycled water were great enough so that the ink would no longer stay dispersed. The ink floated to the surface in large agglomerates and these ink agglomerates were too large to pass through the screen on the Side Hill washer. I tried to adjust the chemicals in the cook to obtain a constant level of TA like that of run A. There was no correlation between the brightness of the pads and the TDS in the used cooking liquior(see graph #3, p.30). I feel that my changing the cooking chemicals between cooks may have influenced the results.

RUN C

The first two cooks dropped 13.4% in brightness from the original newspaper. The ink specks started to appear in the pads after the 2nd cook. When I plotted the brightness of the pads against the TDS in the used cooking liquior(see graph #4,p.31), I obtained some interesting results. The brightness dropped with increasing TDS till 5.5 grams/liter was reached and then it started to rise. The point where the brightness started to rise is where the ink specks started to appear in the pads.

To see if I could increase the brightness of the pulp by washing with fresh water, I split the fifth cook in half. One half(V), I made into pads like the previous cooks in run C. The other half(VI), I washed twice more in the Side Hill washer using fresh tap water each time. This increased the brightness 6.4% over the pads washed with recycled water.

RUN D

During this run I was trying to determine what chemical combination would give me the best results. The first cook was split in half and one half(I) washed in distilled water showed a 18.2% drop in brightness from the original newspaper. There were ink specks present in the pads also. It seems that the NaOH and STPP did not act as a good dispersent for the newspaper ink. The other half(II) was washed with distilled water and NaCL(0.9 g/l) and showed a 23.3% drop in brightness and it also had ink specks in its pads.

The next cook was made with only a surfactant and Na_2-SiO_3. The cook was split in half and washed like the previous cook. The half washed with distilled water(III) showed a 5.1% drop in brightness from the original newspaper. The other half(IV) washed with salt water had a 13.0% drop.

The last cook done in this run used the same chemical combination that was used during the control and the recycled runs. The first half(V) washed with distilled water showed a 9.1% drop in brightness. The other half(VI) had a 15.6% drop.

RUN E

This run was done to determine the effects of washing with water with varying amounts of dissolved solids(NaCL). The results when graphed (see graph #2,p.29) showed a drop in brightness at first till the 2 g/l level of NaCL was reached, then the brightness started to increase. It seems that the TDS in the wash water had an effect upon the brightness , but not a strong one.

RUN F

This run was done to determine the effect TDS had in the new cooking liquior. The results are shown in graph #1, p.28. The graph shows a definite correlation between TDS and the brightness of the pads. The brightness which was only 5% low at first, dropped to 19.1% after the TDS reached 4 g/l.

CONCLUSIONS

After analyzing all the data, it becomes apparent that the TDS have a strong effect on the deinking of newsprint. The TDS seems to have a greater effect when it is in the cooking liquior then when it is in the washing water. It also becomes obvious that NaOH is not a necessary ingredient to deink newspaper. In fact, it seems to have a detrimental effect upon the dispersion ability of the surfactant used to disperse the ink.

I feel that a suitable surfactant and sodium silicate are all the chemicals that are needed to deink newspaper. Also I feel that recycled water can be used for deinking, but its' use would have to be restricted to the wash water. The only problem with using this recycled water would be the 2 to 5% drop in brightness.

FIGURE #1 FLOW DIAGRAM FOR RUNS A-D-E-F

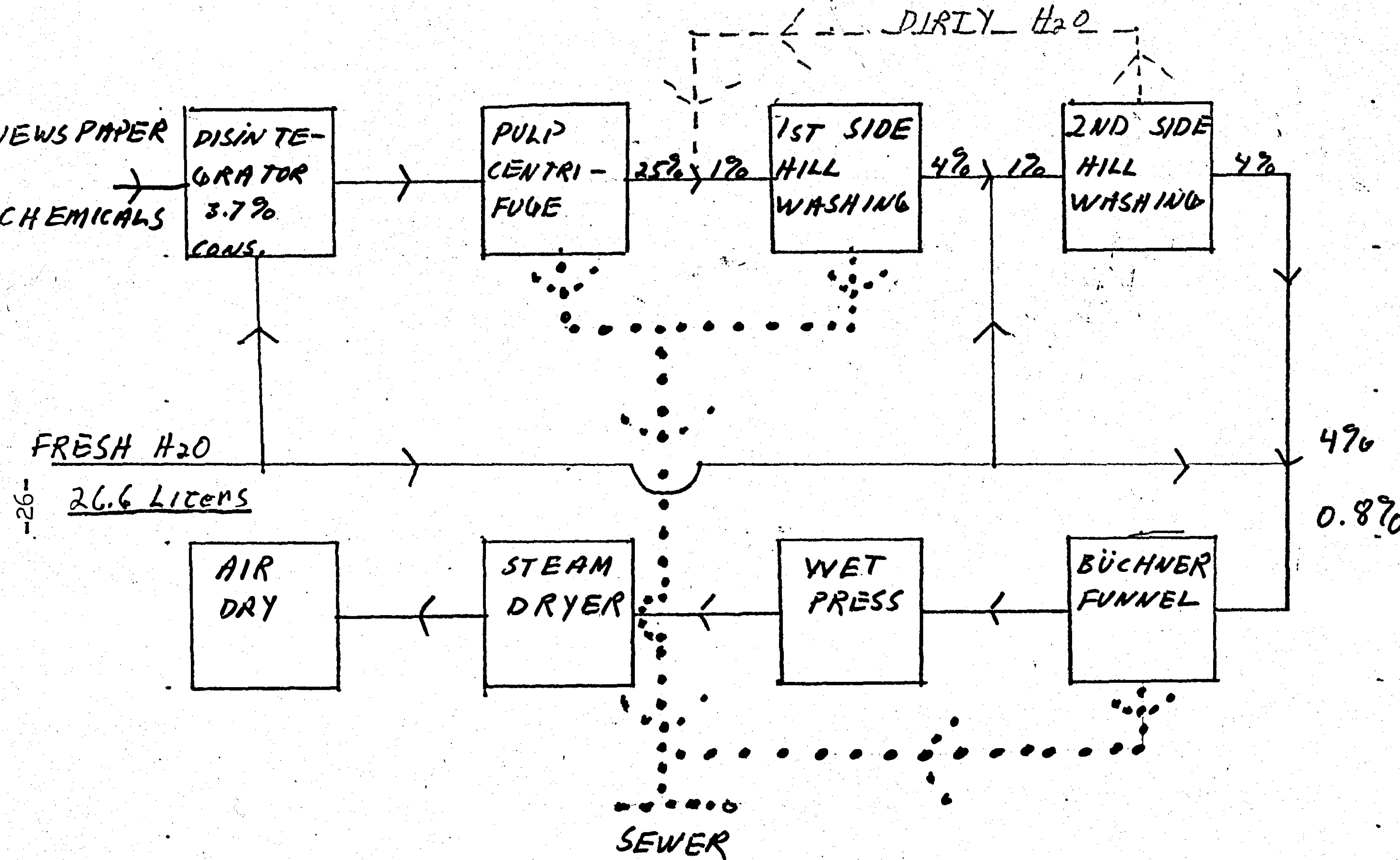
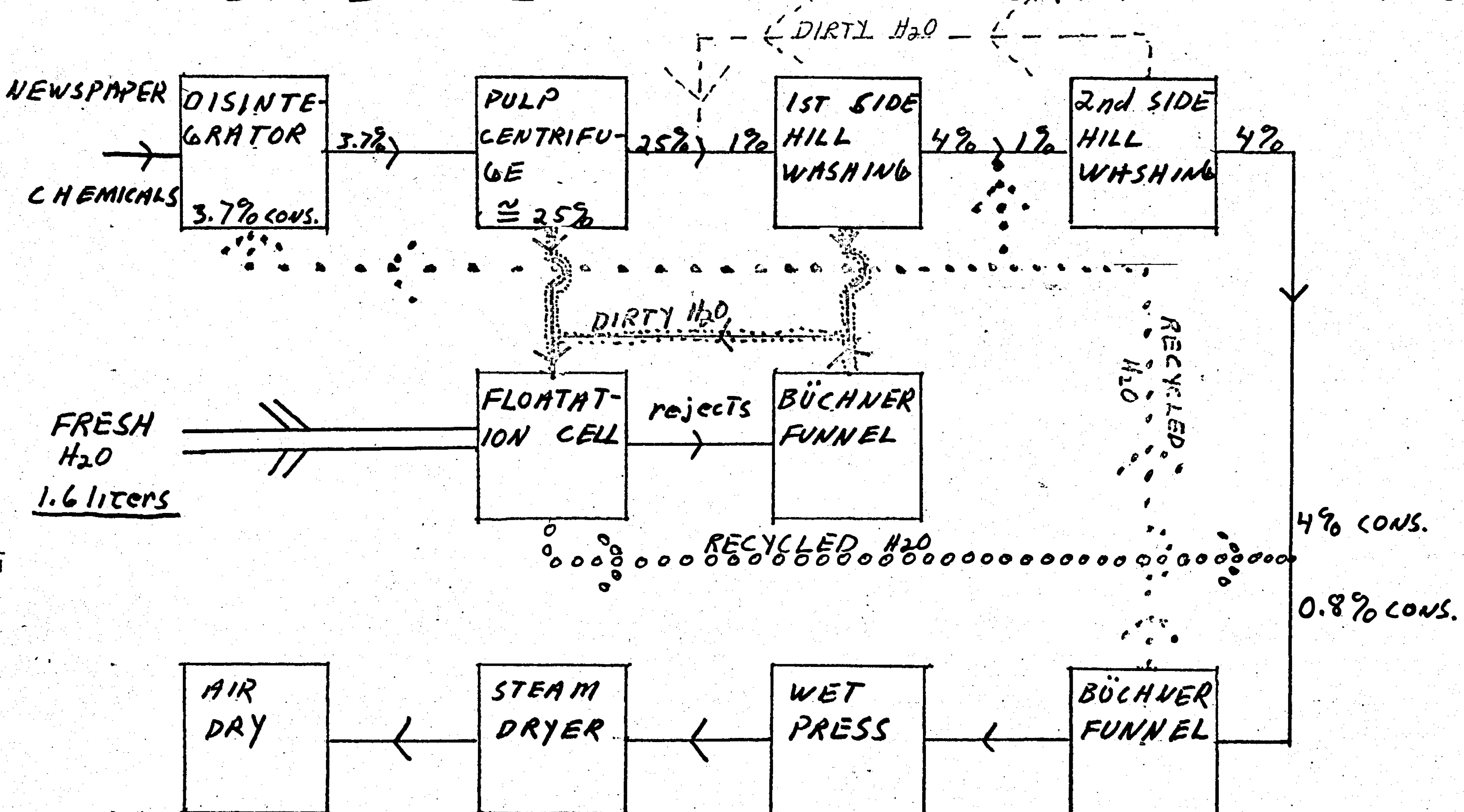
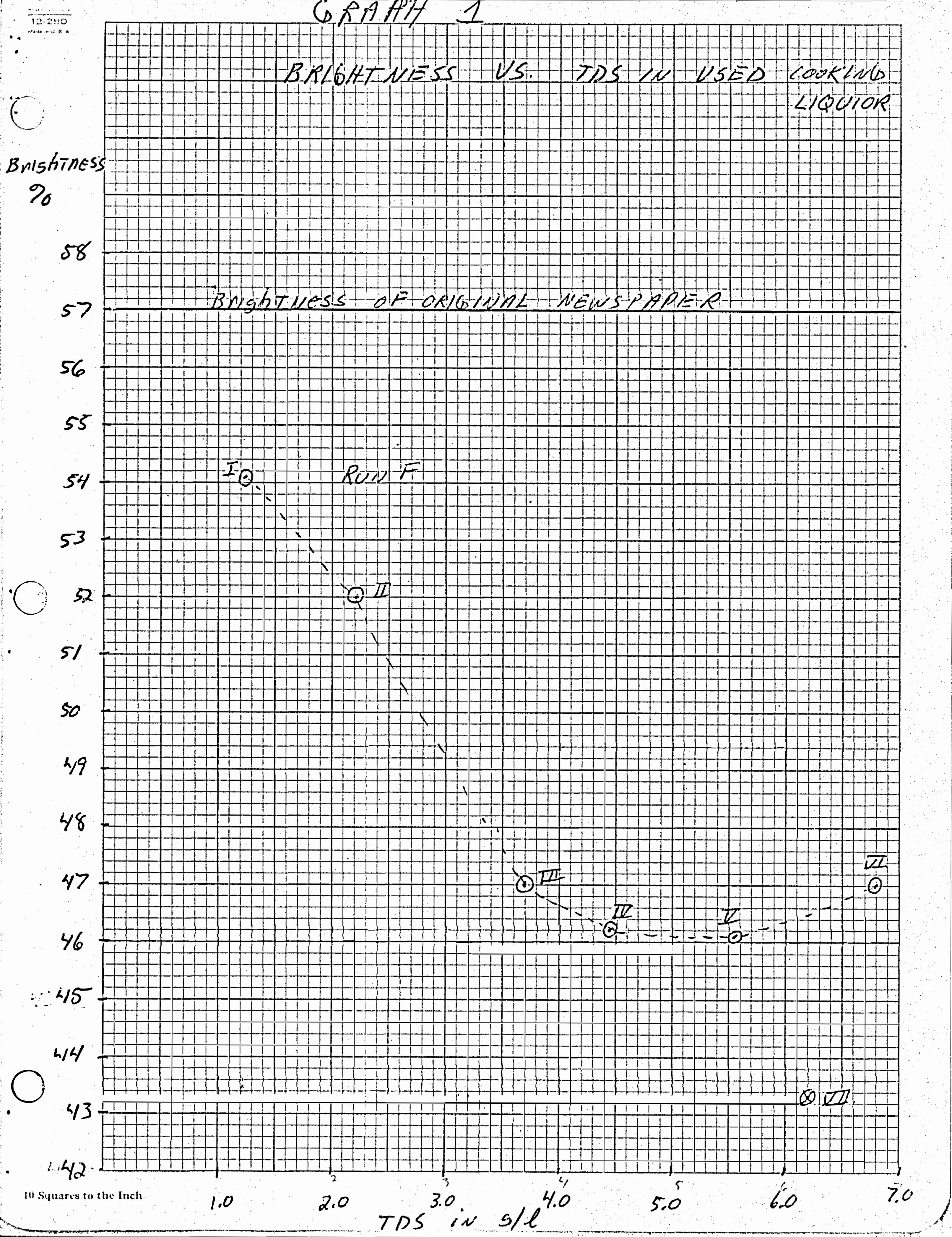
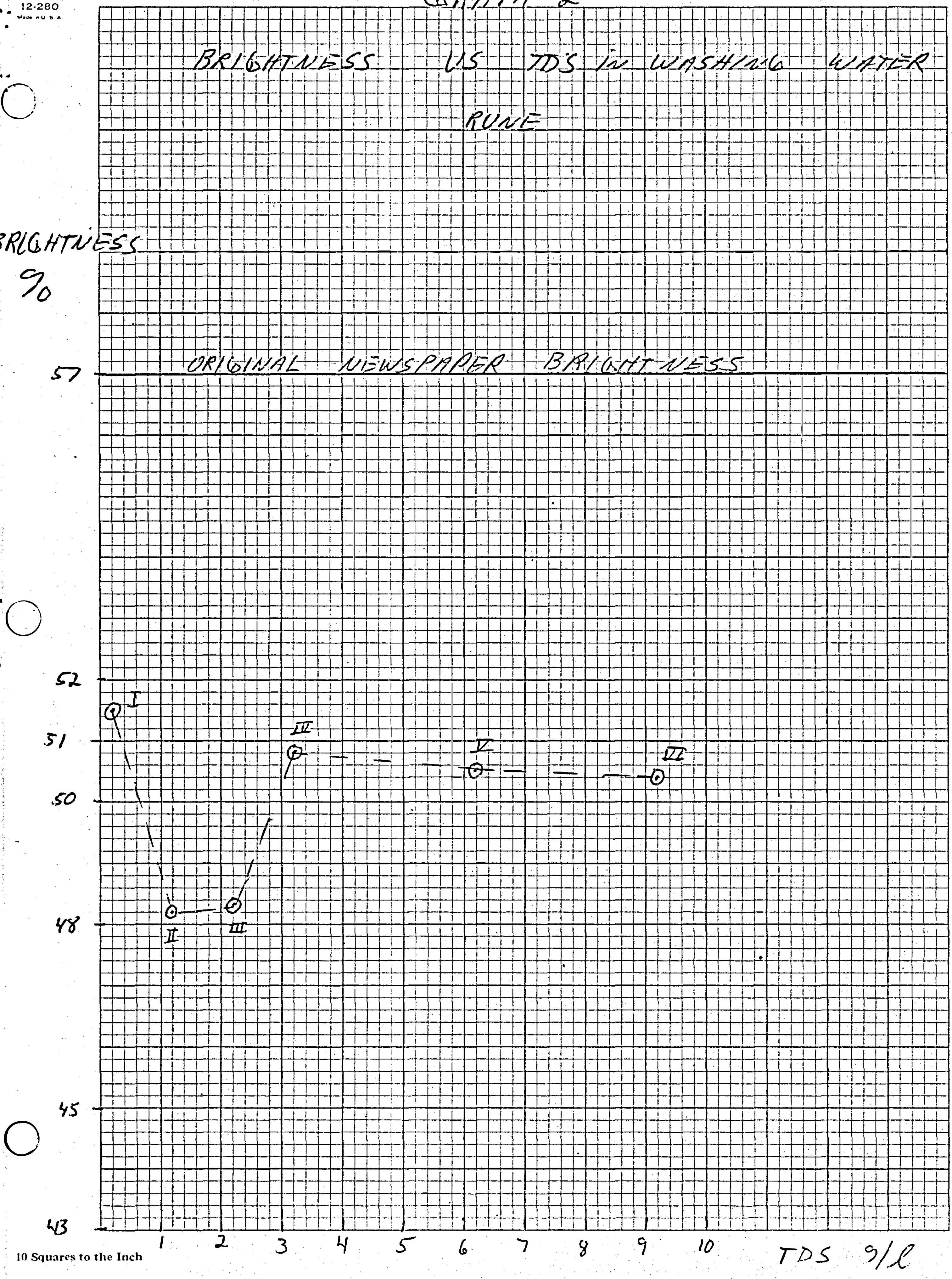


FIGURE #2 FLOW DIAGRAM FOR RUNS B-C

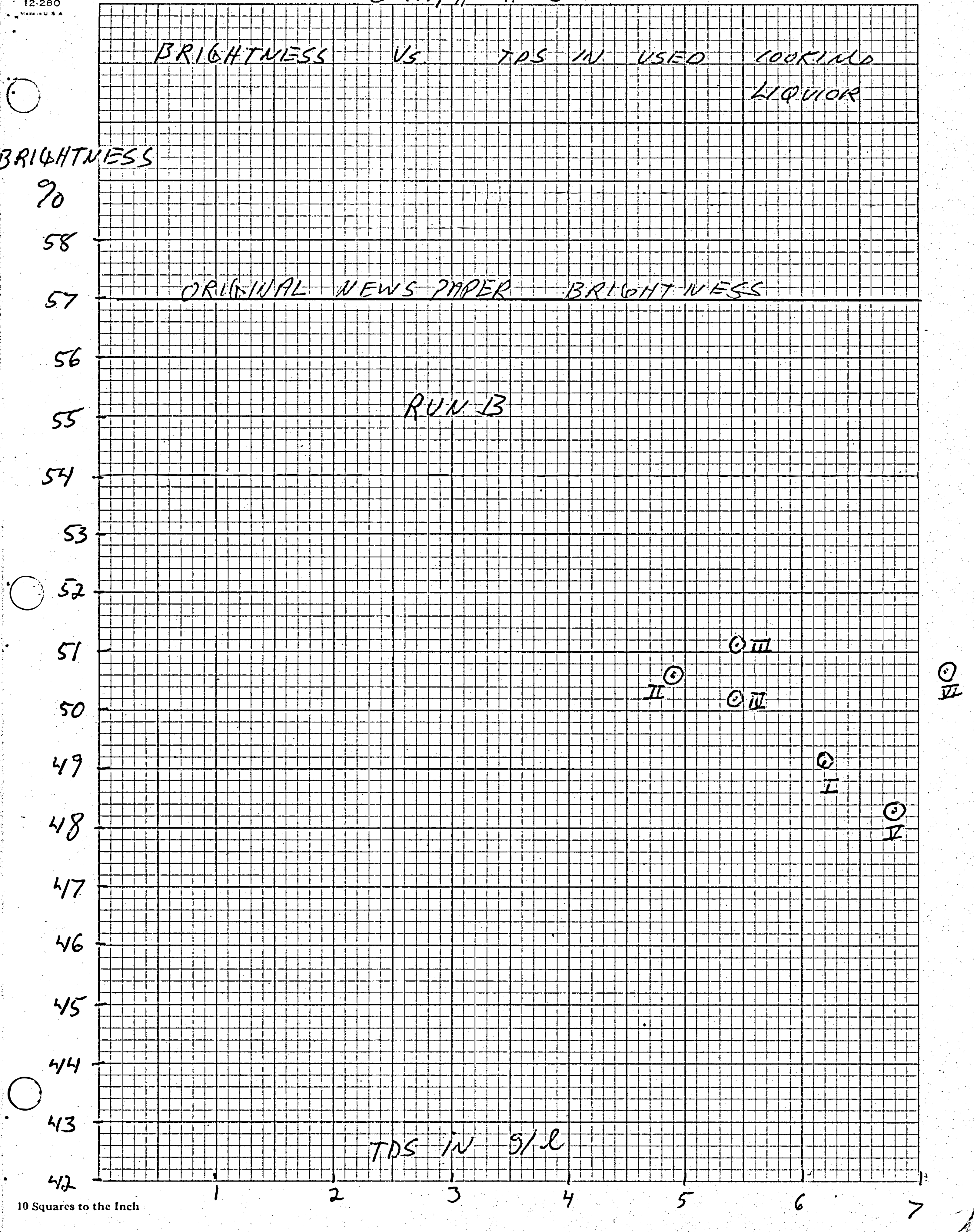



GRAPH 1
BRIGHTNESS VS. TDS IN USED COOKING LIQUOR
Brightness %
58
57
BRIGHTNESS OF ORIGINAL NEWSPAPER
56
55
54
I
RUN F
53
52
II
51
50
49
48
47
III
VI
IV
V
46
45
44
43
VII
42
1.0
2.0
3.0
4.0
5.0
6.0
7.0
TDS in g/l
10 Squares to the Inch

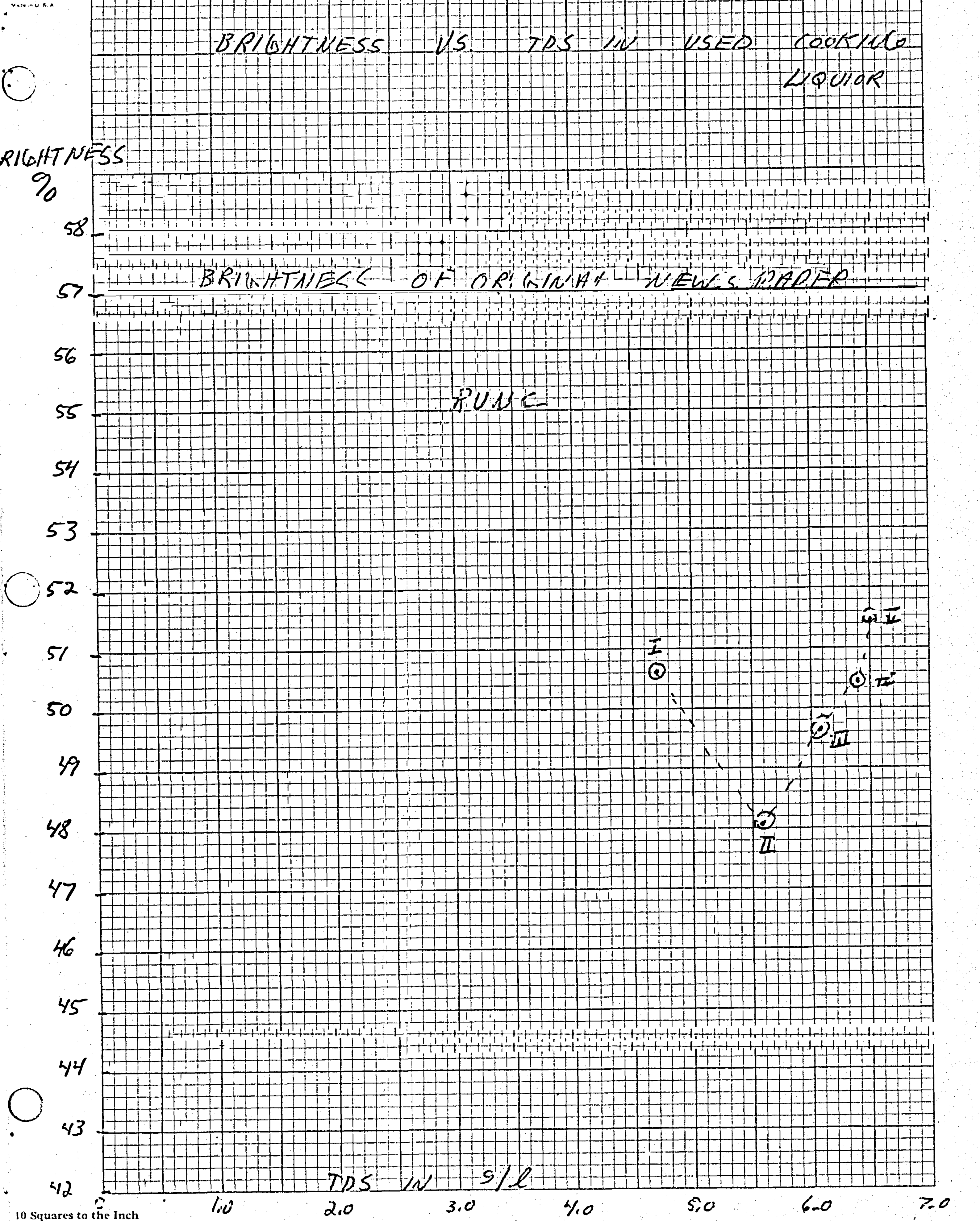
GRAPH 2


BRIGHTNESS VS TDS IN WASHING WATER
RUNE
BRIGHTNESS %
ORIGINAL NEWSPAPER BRIGHTNESS
57
52
51
50
48
45
43
I
II
III
IV
V
VI
1
2
3
4
5
6
7
8
9
10
TDS g/l

GRAPH # 3


BRIGHTNESS VS TDS IN USED COOKING LIQUOR
BRIGHTNESS %
58
57
56
55
54
53
52
51
50
49
48
47
46
45
44
43
42
ORIGINAL NEWS PAPER BRIGHTNESS
RUN B
II
III
IV
I
V
VI
TDS IN g/l
1
2
3
4
5
6
7

GRAPH # 4



10 Squares to the Inch

TABLE # 1

BRIGHTNESS IN % OF THE DEINKED PADS

Run	I	II	III	IV	V	VI	VII
RUN A	50.2	53.4	50.2	51.8	51.2	51.7	
RUN B	49.1	50.6	51.2*	50.2*	48.3*	50.7*	
RUN C	50.6	48.1	49.7*	50.5*	51.5*	54.8*(1)	
RUN D	46.6*	43.7*	54.1	49.6	51.8	48.3	
RUN E	51.5	48.2	48.3	50.8	50.5	50.4	
RUN F	54.1	52.0	47.0	46.2	46.1	47.8	43.3(2)

* referrs to those pads that had ink specks in them

(1) see page 14 for explanation of this high value.

(2) see page 17 for explanation for this low value

TABLE # 2

USED COOKING LIQUIOR ANALYSIS

RUN	TA(1)	TDS(2)	Ph	CONDUCTANCE(3)
A - I	0.908	4.103	9.4	3150
II	0.913	4.405	9.4	2600
III	0.899	3.997	9.4	2600
IV	0.901	4.602	9.4	2450
V	0.903	4.700	9.5	2800
VI	0.942	4.540	9.6	3000
B - I	1.120	6.210	10.5	3650
II	0.720	4.905	10.2	2750
III	0.672	5.440	9.8	2400
IV	0.676	4.945	10.0	2750
V	1.044	6.780	10.2	3500
VI	1.104	7.30	10.4	4150
C - I	0.912	4.675	10.5	3200
II	0.960	5.566	10.4	3600
III	1.008	6.095	10.4	3700
IV	1.072	6.390	10.5	3500
V	1.012	6.450	10.6	3300
VI	1.012	6.450	10.6	3300
D - I-II	1.327	6.985	12.1	6500
III-IV	0.096	2.650	9.2	380
V-VI	0.836	4.485	10.7	2450

(1) TA - total alkali expressed as grams-NaOH/liters used cooking liquior

(2) TDS - total dissolved solids expressed as grams-TDS/liter of used cooking liquior

(3) Conductance expressed as micromhs

TABLE # 2

RUN	TA	TDS	Ph	CONDUCTANCE
E - I-VI	0.0761	3.370	8.5	420
F - I	0.0761	1.725	9.5	880
II	0.0761	2.220	8.7	2850
III	0.080	3.670	8.7	5000
IV	0.0639	4.455	8.5	7200
V	0.0639	5.615	8.5	8800
VI	0.0639	6.770	8.7	9600
VII	0.0720	6.220	8.8	7400

TABLE # 3

NEW COOKING LIQUIOR COMPOSITION

RUN	NaOH	TRITON CF - 10	STPP(3)	WATER GLASS(4)
A - I-VI	3.04(1) 2.3 (2)	2.7g 2.0%	1.4g 1.1%	18.4g 5.3%
B - I	3.04g 2.3%	2.7g 2.0%	1.4g 1.1%	18.4g 5.3%
II-IV	1.5g 1.2%	2.7g 2.0%	1.4g 1.1%	14.2g 4.1%
V				
V	2.43g 1.84%	3.5g 2.7%	1.8g 1.4%	19.5g 5.6%
VI	2.20g 1.7%	3.3g 2.5%	1.7g 1.3%	17.9g 5.2%
C - I	SAME AS RUN B - I			
II-VI	2.4g 1.8%	2.7g 2.0%	1.4g 1.1%	16.6g 4.8%
D -I-II	7.0g 5.3%		7.0g 5.3%	
III-IV		7.0g 5.3%		6.0g 1.7%
V-VI		SAME AS RUN B - I		
E -I-VI		8.11g 6.15%		6.7g 1.9%
F -I-VII		8.0g 6.1%		7.9g 2.3%

(1) Amount in grams added to cook 132(O.D.) of newspaper

(2) % of chemicals added based on the O.D. weight of the newspaper cooked

(3) Sodium Tripolyphosphate

(4) Sodium Silicate - 42° Baume - 38% solids - 3.22 weight ratio of silicate to NaOH

TABLE # 4

COLOR ANALYSIS DATA OF THE BRIGHTNESS PADS

RUN		(1)	PURITY(2)	Yc.i.e.(3)	COLOR
A	I	574nM	11%	60.3%	greenish-yellow
	II	577	11	61.0	yellow
	III	577	8.8	57.7	"
	IV	573	9.5	59.0	greenish-yellow
	V	578	8.0	57.5	yellow
	VI	571	7.8	57.5	"
B	I	578	8.4	55.8	yellow
	II	576	9.0	58.7	"
	III	578	9.4	60.6	"
	IV	578	10.8	60.5	"
	V	577	10.0	57.1	"
	VI	576	9.5	59.9	"
C	I	571	9.8	59.8	greenish-yellow
	II	577	9.5	56.1	yellow
	III	576	10.4	58.2	"
	IV	575	9.5	60.1	"
	V	576	10.2	60.5	"
	VI	577	9.5	63.9	"

(1) dominant wavelength in nanometers

(2) % purity, which is amount of saturation of the basic color with white. 100% purity refers to the pure color with no white mixed in.

(3) Tristimiulous value fot the luminesce in %

TABLE # 4

RUN			PURITY	Ycie	COLOR
D	I	574nM	13.5%	57.6%	greenish-yellow
	II	576	13.5	55.2	yellow
	III	568	7.0	60.7	greenish-yellow
	IV	568	6.8	55.2	"
	V	573	9.4	60.1	"
	VI	572	9.0	55.3	"
E	I	572	7.0	57.1	greenish-yellow
	II	573	7.0	53.1	"
	III	572	6.5	54.1	"
	IV	572	6.1	55.8	"
	V	572	6.0	55.8	"
	VI	570	5.8	55.4	"
F	I	573	7.0	60.4	greenish-yellow
	II	571	6.5	57.9	"
	III	572	5.8	50.9	"
	IV	572	5.0	50.1	"
	V	573	5.5	50.0	"
	VI	568	5.8	52.9	"
	VII	573	7.0	47.7	"

PHOTO # 1

Cooking apparatus consisting of the Disintegrator, 7 liter metal beaker and reostat

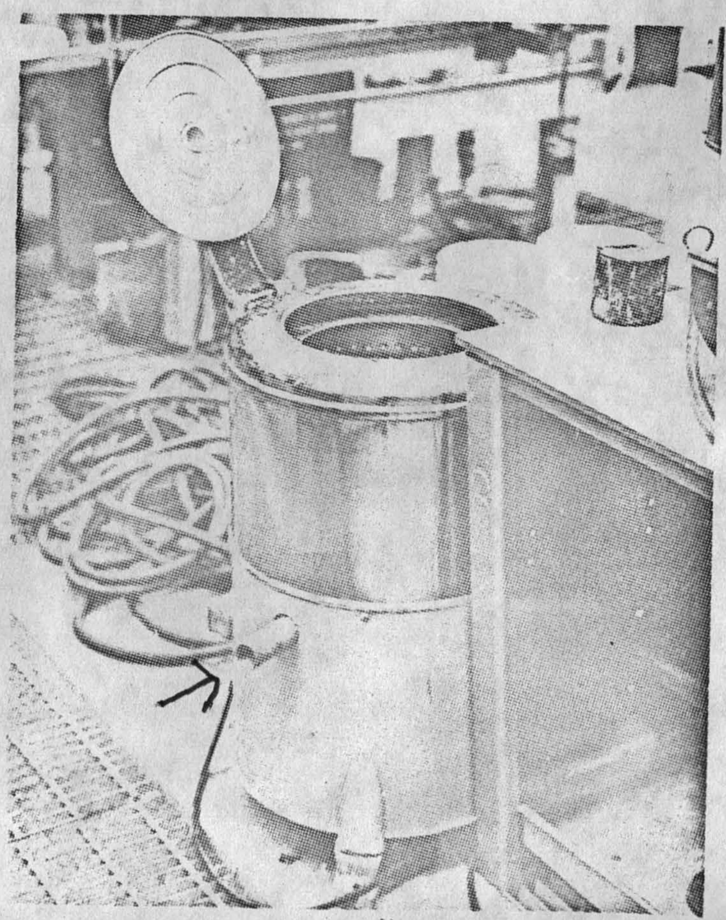


PHOTO # 2

Pulp centrifuge used cooking liquior collected from pipe marked with the blue arrow

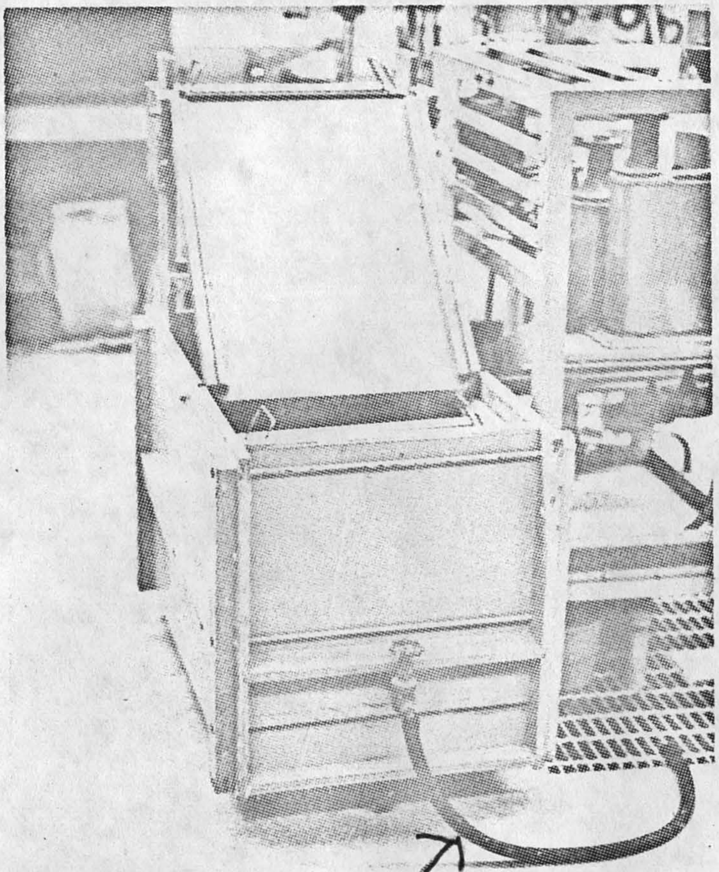


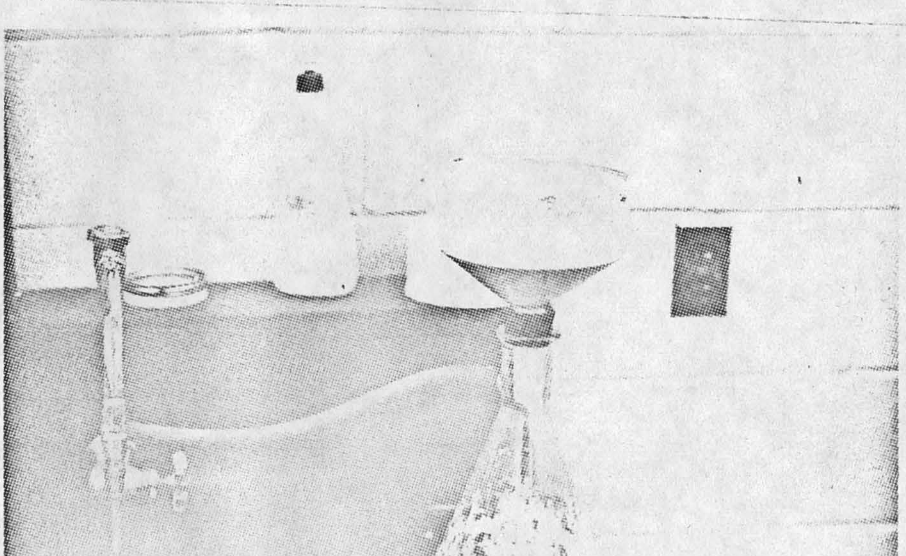
PHOTO # 3

Laboratory Side Hill washer

used wash water collected from hose marked with blue arrow

PHOTO # 4

BÜCHNER funnel



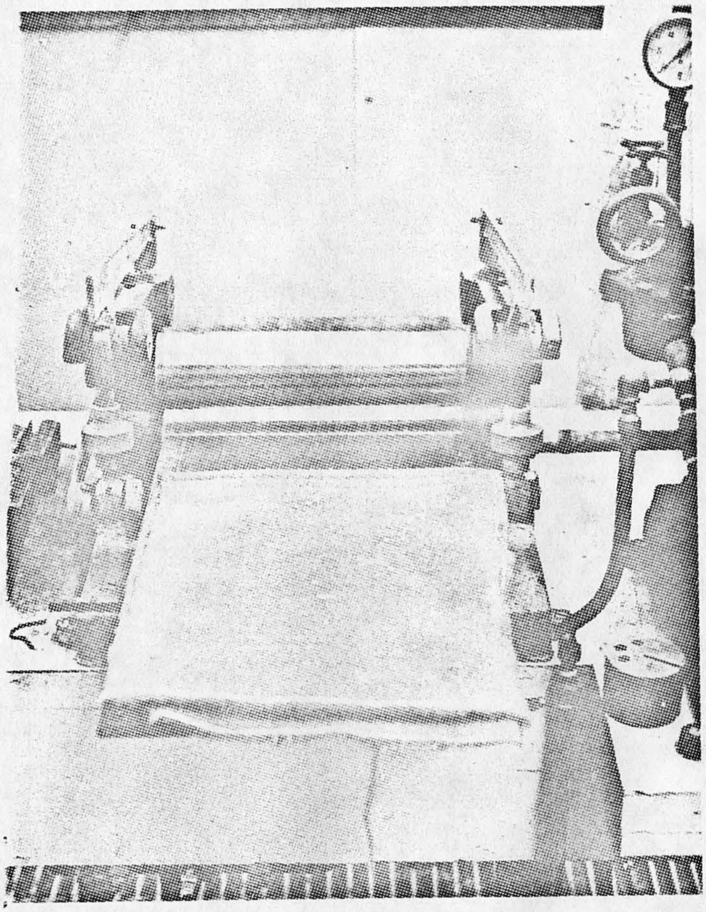


PHOTO # 5

WET PRESS

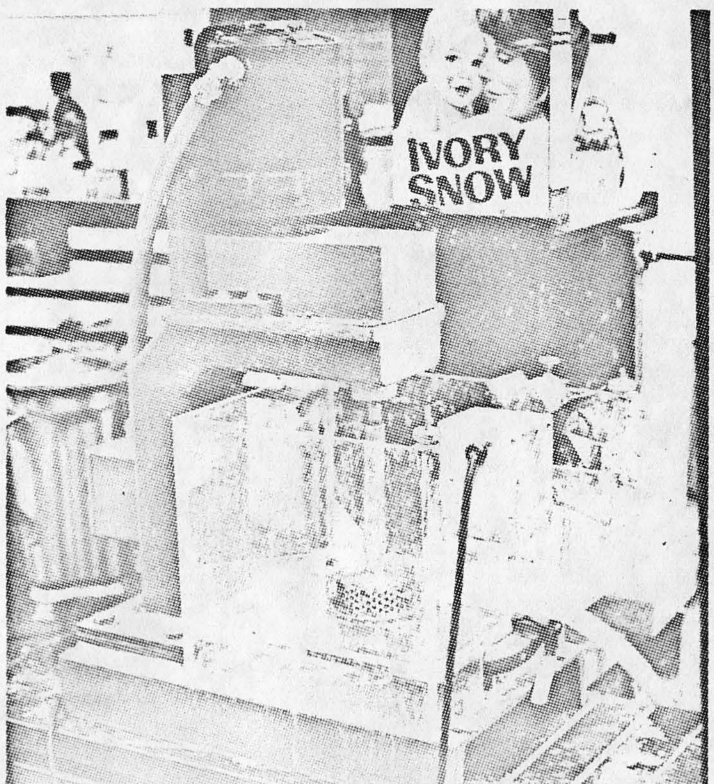


PHOTO # 6

Laboratory floatation cell

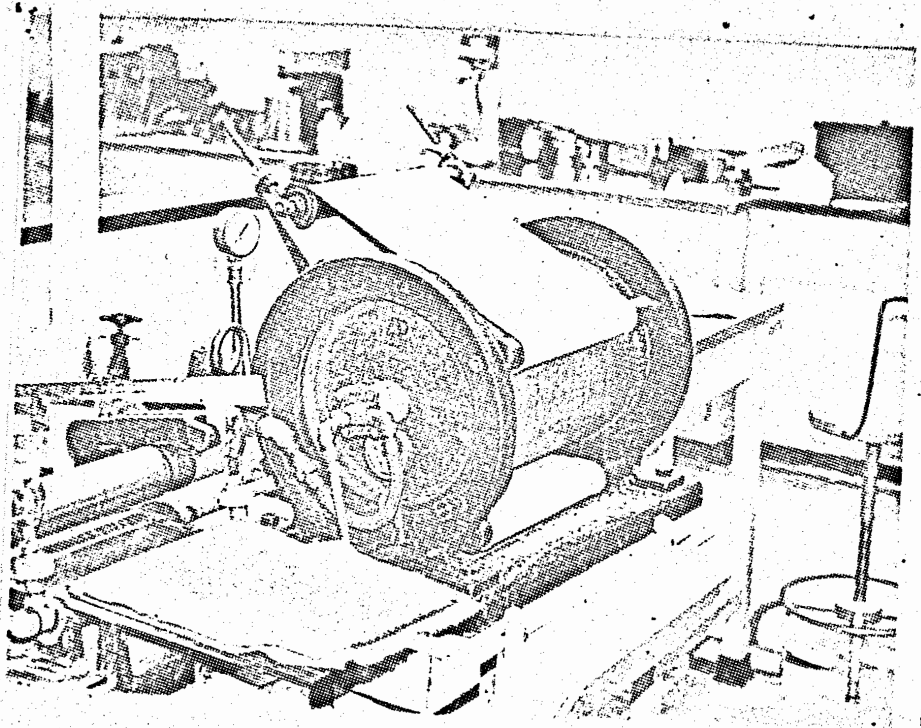


PHOTO # 7

Steam dryer

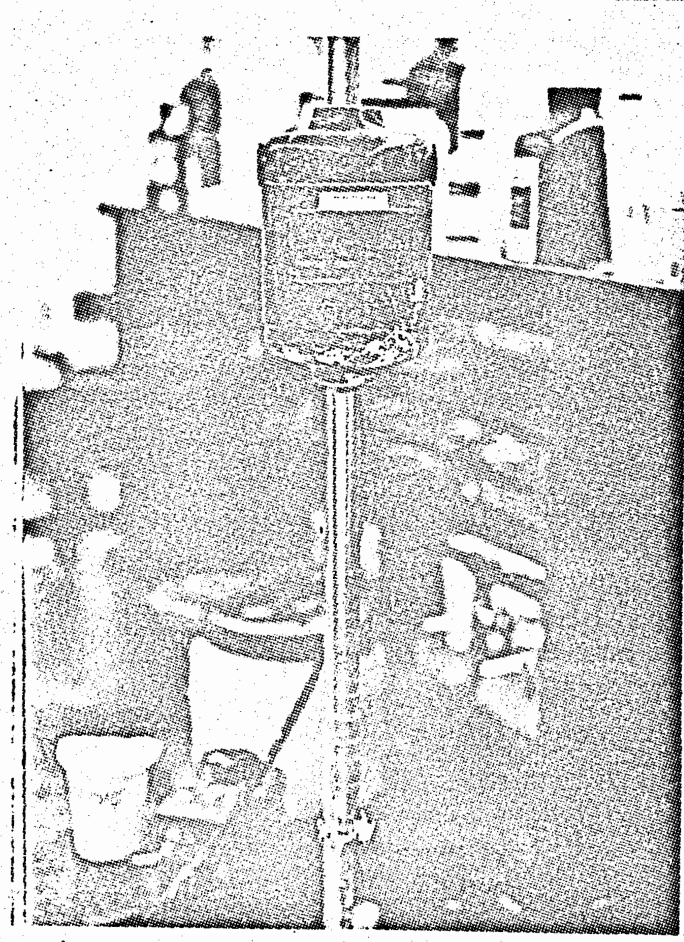


PHOTO # 8

Disintegrator

BRIGHTNESS PAD SAMPLES

RUN A

I II III IV V VI

RUN B

I II III IV V VI

BRIGHTNESS PAD SAMPLES

RUN C

I	II	III	IV	V	VI

RUN D

I	II	III	IV	V	VI

BRIGHTNESS PAD SAMPLES

RUN E

I II III IV V VI

RUN F

I II III IV V VI VII

BIBLIOGRAPHY

1. Joint Text Book Committee of the Paper Industry, "Control, Secondary Fiber, Structural Board and Coating" 2nd Ed., McGraw-Hill Book Co. , (1969) Vol. II, pp. 94-131
2. O'Donaghue,A., Paper Industry Dec.,:911-916 (1940)
3. Kenworthy, I.C., Paper Technology June/Aug., :157-162(1973)
4. Graphics Arts Literature Abstract (G.A.L.A.) Vol. 24 (4) :abst. A0662-77 (1977)
5. G.A.L.A. Vol. 24 (2) :abst. A0364-77 (1977)
6. Felton, A.J., Tappi Vol. 58 (4) :78-85 (1975)
7. Nadelman, A.H., Paper Industry June, :330-336 (1944)
8. Staff, Chemical Week April 6, :30 (1977)
9. Matze, W., Wochenblatt fuer Papierfabrikation Vol. 104 (20) :778-784 (1976)
10. "Deinking of Waste Paper", Tappi Monograph Series No.16, IPC (1956)
11. Reynolds, H.H. and Reuben, M.D., Tappi Vol. 49 (7) :64A-67A (1966)
12. Bechstein, G., Das Osterreichische Papier Vol. 12 (4) :16-29 (1975)
13. Raimondo, F.E., Tappi Vol. 50 (9) :69A-74A (1967)
14. Wood, R.E., Paper Technology June/Aug., :183-188 (1973)
15. Falcone, J.S. and Spencer, R.W., Pulp and Paper Dec. , :114-117 (1975)
16. Turai, L.L. and Williams, L.D., Tappi Vol. 60 (11) :168-169 (1977)

BIBLIOGRAPHY

17. Kashiwabara, S., Jap. pat. 160,501/75 (Dec. 25,1975)

18. Yamada, M. and Okobe, J., Jap. pat. 3772/74 (Oct. 11,197$)

19. Ishikawa,Y. and Takeuchi, S., Jap pat. 26,641/75 (Sept. 2,1975)

20. Dinkfeld, D., "Deinking of Waste Cured with U.V. Ink", Senior Thesis, April,1978

21. Fergison Jr., H.W., "Cooking Variables in Recycling Newspaper", Senior Thesis, April,1978

22. Matzke, W., The Paper Maker May, :38-44 (1972)

23. Galland, G. and Bernard, E. , A.T.I.P. Revue, Vol. 3 (2) :47-55 (1976)

24. "Deinking of Waste Paper", Tappi Monograph Series No. 31, IPC (1967)

25. Cruea, R.P., Tappi Vol. 61 (6) :27-30 (1978)

26. Matthew, J.B., Tappi Vol. 59 (5) :101-104 (1976)