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THE EFFECT OF LOCUST BEAN GUM UPON THE IRREVERSIBLE DEHYDRATION OF MITSCHERLICH BLEACHED SULFITE PULP

Summary

There is quite a difference between the strength properties of undried and air-dried Mitscherlich bleached sulfite pulp. Heat drying the pulp increases this difference a little.

Treating the pulp first with 5% locust bean gum based on the fibers and then beating the pulp undried gives a high initial bursting strength which falls off sharply upon further beating as compared with the undried pulp.

Treating the pulp with 5% locust bean gum based on the fibers and drying before beating gives initially the same or slightly higher bursting strength as compared to the undried pulp, but this bursting strength also drops upon further beating.

Heat-dried Mitscherlich bleached sulfite pulp was beaten and had 5% locust bean gum added after beating. The paper showed great improvements in strength properties especially upon long beating.

This study has shown that for short beating times the pulp should be gum treated and dried. Upon short beating this pulp will regain or surpass the strength properties of the undried pulp.

For long periods of beating, the pulp should be dried and then gum added during or after beating. This treatment will probably give much

greater strength properties than the undried pulp.

Introduction:

In the Project Report 26 for Project 849, the effect of locust bean gum upon the irreversible dehydration of southern pine kraft pulp was studied, but there was not a large enough difference between the undried and air-dried samples of pulp to indicate much irreversible dehydration.

A non-kraft pulp would probably show more irreversible dehydration, so Mitscherlich bleached sulfite was used in this study.

The Mitscherlich bleached sulfite pulp was obtained in wet lap form from the Interlake Pulp and Paper Company, Division of Consolidated Water Power and Paper Company.

The same type of experiments were carried out on this pulp as were carried out on the southern pine kraft pulp.

Experimental:

The moisture content of the wet lap Mitscherlich bleached sulfite pulp was 68.6%, requiring 1150 grams of wet pulp to yield 360 grams of ovendry pulp.

A beater load of a little over 1160 grams of wet pulp was put in the Valley Beater and slushed for 5 minutes. The Schopper-Riegler freeness was 853 cc. The pulp was beaten with 5500 grams plus the balance weight on the bed plate for 10 minutes to a Schopper-Riegler freeness of 801 cc. The pulp was removed from the beater and drained through a drain box. The pulp was then pressed in a small wine press to remove the excess water. The pulp was crumbed onto a wire screen to air dry.

Another beater run of 1160 grams of wet pulp was treated in exactly the same manner as above.

A beater run of 1150 grams of wet pulp was slushed in the Valley Beater for 5 minutes and beaten with 5500 grams plus the balance weight on the bed plate for 10, 20, and 30 minutes at which times one liter samples were removed for making handsheets. The one liter samples were diluted to three liters and freeness determinations were made. The remainder of the solutions were made into handsheets. The handsheets were made on the Valley Sheetmold and pressed on the British handsheet press in the Pulping Laboratory at 50 lbs./sq. in. for 5 minutes. The handsheets were then dried on a steam drier at 3 lbs./sq. in. for 3 minutes.

One of the air-dried beater runs had a moisture content of 17.4% and was soaked for 4 hours. The pulp was slushed for 10 minutes in the Valley Beater to remove the knots in the dried pulp and then was beaten with 5500 grams plus the balance weight for 5, 15 and 25 minutes at which times one liter samples were removed and treated as before.

The other air-dried beater run was placed in an oven at 105-110° C. for 1/2 hour and then was soaked for 4 hours before beating. [No moisture determination was made.] The pulp was slushed for 10 minutes to remove most of the knots due to the drying of the pulp and then beaten for 5, 15, and 25 minutes with 5500 grams plus the balance weight on the bed plate. Pulp samples were removed and treated as above.

A beater run was made by slushing 1150 grams of wet pulp for 5 minutes and beating it for 10 minutes with 5500 grams plus the balance weight on the bed plate. The pulp was put in a crock and 18 grams of cooked locust bean gum were added with stirring. The locust bean gum dispersion is made by dusting 18 grams of locust bean gum into 1800 mls. of water and heating the solution to 85-90° C. The temperature is held constant for 15 minutes whereupon the dispersion is diluted with water to a total weight of 3600 grams, making a 0.5% gum dispersion. The gum dispersion is stirred until the temperature reaches room temperature. The cooled gum is then added to the pulp. The pulp was stirred for several hours and allowed to stand over night in contact with the locust bean gum. The next day the pulp was drained through a drain box and pressed in a small wine press to remove the excess gum. The pressed pulp was then slushed for 5 minutes before it dried out and was beaten for 5, 15, and 25 minutes with 5500 grams plus the balance weight. Samples of pulp were taken and treated the same as before.

A beater run was made by slushing 1150 grams of wet pulp for 5 minutes and beating it for 10 minutes with the same bed plate load as before. The pulp was sucked dry of excess water by vacuum filtering and was then broken up into small pieces by a dry pulp disintegrator. The pulp was spread out to air dry over night. The pulp was air dried to 5% moisture and then placed in an oven at 105-110° C. for 1 1/2 hours drying the pulp to 1% moisture. After soaking for 4 hours, the pulp was slushed 10 minutes and beaten for 5, 15, and 25 minutes with the same bed plate load as before. Samples of pulp were removed at these times and treated as before.

A beater run on undried pulp was made as before and put in a crock. To this pulp, eighteen grams of cooked locust bean gum were added with stirring and allowed to stand over night. [All pulp slurries with locust bean gum had 5% gum based on the fibers.]

The gum treated pulp was drained of all excess gum and sucked as dry as possible on a vacuum filter. The pulp was broken up and spread out to air dry. The air-dried pulp had a moisture content of 7.4%. The pulp was put in an oven and dried at 105° C. for 1 1/2 hours to a moisture content of 1%. The pulp was then soaked for 4 hours before slushing for 10 minutes in the Valley Beater. The pulp was beaten for 5, 15, and 25 minutes with the same bed plate load as before. Samples of pulp were taken and treated as before.

A beater run was made by slushing 1150 grams of wet pulp for 5 minutes in the Valley Beater and beating with the same bed plate load for 10 minutes. The pulp was put in a crock and treated with 18 grams of cooked locust bean gum as before. The gum treated pulp had the excess gum removed by vacuum filtering. The pulp was broken up and spread out to dry. An electric fan was used to speed up the drying. The air-dried pulp had a moisture content of 6.6%. The pulp was soaked for 4 hours and slushed for 5 minutes in the Valley Beater. [This pulp slushed well after 5 minutes without knots and therefore did not need to be slushed for 10 minutes.] The pulp was beaten for 5, 15, and 25 minutes with the same bed plate load described previously. Samples of pulp were removed and handsheets made as before.

A beater run was made by slushing 1150 grams of undried pulp for 5 minutes. The pulp was beaten for 10 minutes with the same bed plate load. The pulp was filtered through a large vacuum filter and broken up by a dry pulp disintegrator and spread out to air dry. The moisture content upon air drying over night was 7.6%. The pulp was then put in an oven at 105° C. for 1 1/2 hours to dry. At the end of this time, the pulp was still not dry enough, so the pulp was put in the oven again for another hour. The moisture content was slightly over 1%.

The oven-dried pulp was soaked for 4 hours and slushed for 10 minutes in the Valley Beater. The pulp was beaten for 5, 15, and 25 minutes with the same bed plate load. Samples of pulp were removed at these times and diluted to 0.5% consistency. Locust bean gum (5% based on the fibers) was added and stirred for 30 minutes before handsheets were made. The handsheets were made the same as before.

All the handsheets were tested for basis weight, burst, tear, and M.I.T. fold. The handsheet strength data for these beater evaluations under the various conditions noted are in Table I.

TABLE I

HANDSHEET STRENGTH DATA ON MITSCHERLICH SULFITE PULP
TREATED IN VARIOUS WAYS
(5500 grams plus balance weight)

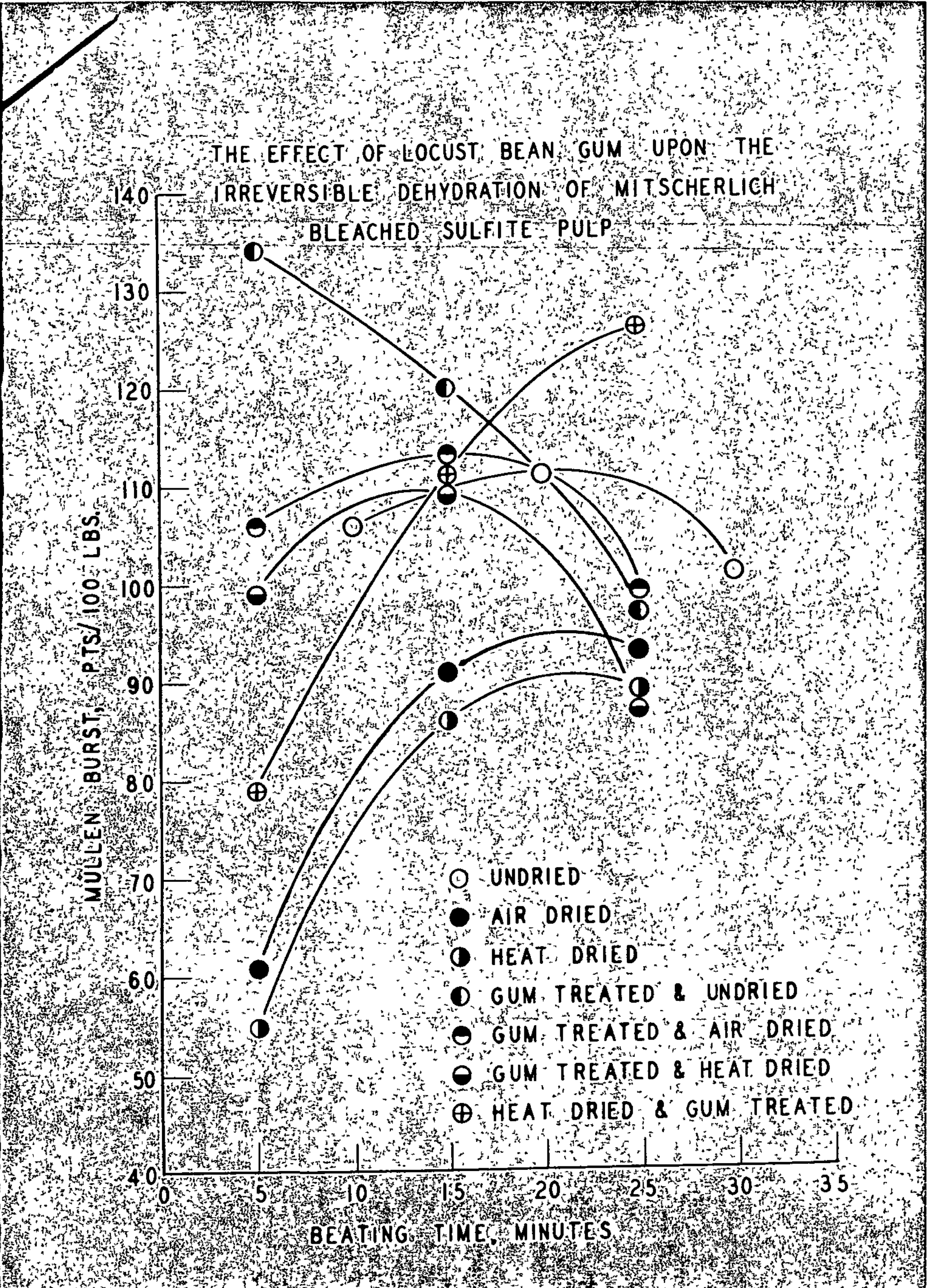
Beating Time, min.	Schopper-Riegler Freeness, cc.	Basis Weight	Mullen Burst, pts./100 lbs.	Tear Factor	M.I.T. Fold
		Undried Pulp			
10	798	44.8	106	0.94	285
20	578	43.4	111	0.65	798
30	400	44.8	101	0.60	1720
		Air-Dried Pulp			
5	792	47.5	61	1.43	55
15	595	45.5	91	0.99	255
25	380	45.9	93	0.74	477
		Heat-Dried Pulp - 1/2 Hour			
5	806	46.9	54	1.60	42
15	636	44.2	81	1.00	293
25	457	45.0	91	0.82	555
		Heat-Dried Pulp - 1 1/2 Hours			
5	813	45.1	55	1.49	34
15	640	44.4	86	0.97	229
25	450	41.8	89	0.69	365
		Gum-Treated and Undried Pulp			
5	760	44.9	134	0.65	1780
15	750	44.9	120	0.53	2110
25	700	46.1	97	0.48	2050

TABLE I (Continued)

HANDSHEET STRENGTH DATA ON MITSCHERLICH SULFITE PULP TREATED IN VARIOUS WAYS
(5500 grams plus balance weight)

Beating Time, min.	Schopper-Riegler Freeness, cc.	Basis Weight	Mullen Burst, pts./100 lbs.	Tear Factor	M.I.T. Fold
	Gum-Treated and Air-Dried Pulp				
5	775	45.9	106	0.89	558
15	745	45.4	113	0.75	911
25	690	42.9	99	0.68	1280
	Gum-Treated and Heat-Dried Pulp				
5	767	45.4	99	0.86	251
15	702	44.4	109	0.72	492
25	620	45.4	87	0.64	693
	Heat-Dried and Gum Added to Pulp				
5	788	43.8	79	1.16	201
15	530	43.9	111	0.82	1180
25	258	42.7	126	0.73	1650

The effect of locust bean gum upon the irreversible dehydration of Mitscherlich bleached sulfite pulp, or, in other words, upon the relationship between bursting strength and beating time will be found in the following figure.


THE EFFECT OF LOCUST BEAN GUM UPON THE IRREVERSIBLE DEHYDRATION OF MITSCHERLICH BLEACHED SULFITE PULP
MULLEN BURST, PTS/ 100 LBS.
BEATING TIME, MINUTES
140
130
120
110
100
90
80
70
60
50
40
0
5
10
15
20
25
30
35
UNDRIED
AIR DRIED
HEAT DRIED
GUM TREATED & UNDRIED
GUM TREATED & AIR DRIED
GUM TREATED & HEAT DRIED
HEAT DRIED & GUM TREATED

Discussion of Results:

From the above figure it can be seen that there is quite a difference between the bursting strength of the undried pulp and the air-dried pulp. Heat drying the pulp increases this difference a little.

Treating the pulp with gum and then beating before the pulp dries gives a high initial strength, but upon further beating, the strength drops off rapidly. This can be explained by the fact that there is a definite amount of gum present and no excess. The beating increases the surface area of the pulp, so that with a great deal of beating there is a very large surface area that is not in contact with the gum which decreases the strength of the pulp.

There is a slightly different effect when the pulp is dried with gum present. The initial beating developes some strength, but upon further beating the strength drops off fairly rapidly. Again the heat-dried pulp is lower than the air-dried pulp.

When the pulp is heat-dried first and then beaten and locust bean gum added, the strength increases as the heating progresses. This fact is due to the increased surface area created by beating. Also, there is 5% gum present which is an excess amount. Pulp will usually absorb completely 1% of locust bean gum. The excess gum and the increased surface area account for the increase in strength properties of the Mitscherlich bleached sulfite pulp.

From the figure it can be seen that if very little beating is going to be done, the pulp should be gum-treated and allowed to dry. Then upon short beating times the pulp will regain or surpass the strength of the undried pulp.

If, however, there is going to be long periods of beating, the pulp should be dried and then the gum added to the beater or to the already beaten pulp.

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THE COMPARISON OF ISCO VAT GUM WITH ISCO SUPERIOR LOCUST BEAN GUM FOR PURPOSES AS A BEATER ADDITIVE

SUMMARY

Adding borax solution to a sample of cooked ISCO Vat Gum did not cause a gel to form nor did it cause the viscosity to change. When borax is added to mannogalactan gums, such as locust bean gum, a gel sets up between the gum and borax. Since the Vat Gum failed to give a gel, it is not a mannogalactan gum, or if it is a mannogalactan gum, it is very highly degraded.

The addition of 2% Vat Gum to Weyerhaeuser bleached sulfite handsheets gives almost the same strength properties, except for fold, as 1% Superior Locust Bean Gum does. The 2% Vat Gum gives a 36.7% increase in burst, while the 1% Superior Locust Bean Gum gives a 38.4% increase in burst.

This study shows that if the Vat Gum is to be used economically as a beater additive, then the cost of the Vat Gum will have to be much lower than the cost of the Superior Locust Bean Gum since it takes twice as much Vat Gum as Locust Bean Gum to produce the same results. However, if a paper is desired that will have a high fold, the Locust Bean Gum would be superior, even at low concentrations on the pulp.

INTRODUCTION

Two samples of gum were received from Innis, Speiden & Company, New York City. One sample was called ISCO Vat Gum, and the other was called ISCO Superior Locust Bean Gum. The vat gum was compared with the locust bean gum for beater additive properties.

EXPERIMENTAL

A sample of each gum was weighed into a weighing bottle and put in the oven at 105° C. No duplicates were run because only an approximation of the moisture content was desired.

The vat gum was 88.1% solids, and the locust bean gum was 85.8% solids.

A 5 gram sample (ovendry) of ISCO Vat Gum was weighed and dusted into a tared beaker containing about 500 mls. of distilled water. The gum solution was heated by direct steam to a temperature of 90° C. for 15 minutes. The gum dispersion was diluted with water to a total weight of 1000 grams, making a 0.5% solids dispersion. The dispersion was stirred until cool and stored in the refrigerator.

The cooled dispersion was not very viscous like locust bean gum dispersions are. A sample of the cooked gum dispersion was poured into a test tube and borax solution was added. The mixture did not gel or change its viscosity. All mannogalactan gums, like locust bean gum will gel when borax is added. Therefore, vat gum is not a mannogalactan gum or else it is a very degraded mannogalactan gum.

Another gum dispersion was made by cooking ISCO Superior Locust Bean Gum just like the vat gum above. The cooled dispersion was fairly viscous.

A beater rum was made by soaking 380 g. of Weyerhaeuser bleached sulfite pulp overnight and slushing it for 5 minutes in the Valley Beater. The pulp was beaten with 4500 grams plus the balance weight on the bed plate for 25 minutes to a Schopper-Riegler freeness of 770 cc. The consistency in the beater was 1.524%.

Twenty-five grams of the pulp beaten above were diluted to five liters and handsheets were made using 302 mls. of pulp solution. The freeness of the pulp was 753 cc. S.-R. The handsheets were pressed at 50 lbs./sq. in. for 5 minutes and dried on a steam drier at 3 lbs./sq. in. for 3 minutes.

Twenty-five grams of pulp were diluted to 5 liters with 25 g. of 0.5% ISCO Vat Gum dispersion making 0.5% gum on the weight of the fibers. The pulp furnish was stirred for 1/2 hour. Handsheets were made using 303 mls. of pulp furnish. The freeness of the pulp was 740 cc. S.-R. The handsheets were pressed and dried the same as above.

Twenty-five grams of pulp were diluted to 5 liters containing 50 grams of 0.5% ISCO Vat gum dispersion, making 1% gum based on the weight of the pulp. The pulp was stirred for 1/2 hour. Handsheets were made using 297 mls. of pulp. The freeness of the pulp was 718 cc. S.-R. The handsheets were treated the same as before.

Twenty-five grams of pulp were diluted to 5 liters containing 100 grams of 0.5% ISCO Vat Gum dispersion, making 2% gum based on the pulp. The pulp was stirred 1/2 hour. Handsheets were made using 305 mls. of pulp. The freeness of the pulp was 716 cc. S.-R. The handsheets were treated the same as before.

Twenty-five grams of pulp were diluted to 5 liters containing 25 grams of 0.5% ISCO Superior Locust Bean Gum dispersion, making 0.5% gum on the pulp. The pulp was stirred 1/2 hour. Handsheets were made using 311 mls. of pulp. The freeness of the pulp was 710 cc. S.-R. The handsheets were treated the same as before.

Twenty-five grams of pulp were diluted to 5 liters containing 50 grams of ISCO Superior Locust Bean Gum dispersion, making 1% gum on the pulp. The pulp furnish was stirred 1/2 hour. Handsheets were made using 294 mls. of pulp. The freeness of the pulp was 707 cc. S.-R. The handsheets had the same treatment.

Twenty-five grams of pulp were diluted to 5 liters containing 100 grams of ISCO Superior Locust Bean Gum dispersion, making 2% gum on the pulp. The pulp was stirred for 1/2 hour. Handsheets were made using 303 mls. of pulp. The freeness of the pulp was 685 cc. S.-R. The handsheets had the same treatment.

All of the handsheets were tested for basis weight, burst, tear, M.I.T. fold, and tensile. The data for these tests are in Table I.

TABLE I

HANDSHEET DATA FOR WEYERHAEUSER BLEACHED SULFITE TREATED WITH ISCO VAT GUM AND ISCO SUPERIOR LOCUST BEAN GUM
(4500 grams plus balance weight)

Gum Added % on Pulp	Schopper-Riegler Freeness, cc.	Basis Weight	Mullen Burst, pts./100 lbs.	% Increase in Burst	Tear Factor	M.I.T. Fold	Schopper Tensile, lb./inch
0	770	44.1	60	—	1.38	93	14.3
			ISCO VAT GUM				
0.5	740	44.2	68	13.3	1.27	140	15.9
1.0	718	44.1	75	25.0	1.29	163	16.3
2.0	716	44.6	82	36.7	1.17	194	17.3
			ISCO SUPERIOR LOCUST BEAN GUM				
0.5	710	44.8	81	35.0	1.23	215	17.4
1.0	707	42.4	83	38.4	1.16	275	17.1
2.0	685	43.6	87	45.0	1.10	378	19.5

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DISCUSSION OF RESULTS

Table I shows that 2% Vat Gum is almost equivalent to 1% Superior Locust Bean Gum. The locust bean gum, however, gives a much higher fold than the vat gum.

Two percent of the Vat Gum gives a 36.7% increase in burst, while 1 and 2% of Superior Locust Bean Gum gives 38.4 and 45.0% increase in burst, respectively.

If ISCO Vat Gum is much cheaper than ISCO Superior Locust Bean Gum, then it could be used economically as a beater additive. The cost of the Vat Gum would have to be much lower than the cost of the Locust Bean Gum since it takes twice as much Vat Gum as Locust Bean Gum to give the same results. However, if a paper is desired that will have a high fold, the Locust Bean Gum would be superior, even at low concentrations on the pulp.

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THE EVALUATION OF ISCO BASE WSX-3 AS A BEATER ADDITIVE

SUMMARY

The data show that there is not much improvement in the strength properties of Weyerhaeuser bleached sulfite by the addition of ISCO Base WSX-3. The wet strength is increased only 8%.

INTRODUCTION

A sample of ISCO Base WSX-3 was received from Innis, Speiden & Company, New York. The manufacturer stated that this product had properties of a beater additive. These properties were investigated.

EXPERIMENTAL

The solids content of ISCO Base WSX-3 was determined as 18.05%.

A sample of WSX-3 was pipetted into 20 mls. of water (.005 g. of solid) and .005 g. of alum (based as solid) was added to flocculate the base. The base was flocculated after several minutes and the pH was 4.3. This illustrates the fact that ISCO Base can be flocced by alum.

A beater run was made by soaking 378 grams of Weyerhaeuser bleached sulfite for 4 hours and then slushing the pulp for 5 minutes in the Valley Beater. The pulp was beaten for 25 minutes with 4500 grams plus the balance weight on the bed plate to a Schopper-Riegler freeness of 743 cc.

Twenty-five grams of this pulp were diluted to 5 liters and handsheets were made, pressed at 50 lbs./sq. in. for 5 minutes, and dried on a steam drier at 3 lbs/sq. in. for 3 minutes.

Twenty-five grams of pulp were diluted to 5 liters and 6.94 mls. of WSX-3 were added making 5% based on the fibers. The slurry was stirred for 5 minutes. Forty-five mls. of 2.5% alum were added making 4.5% alum based on the fibers. The slurry was stirred for 5 minutes. The pH was 4.6 and was lowered to 4.5 by adding a little 2% sulfuric acid. The pH in the sheetmold was adjusted to 4.5 by adding 6.5 mls. of 2% sulfuric acid. The sheets were pressed and dried as before.

The results of the handsheet tests are in Table I.

TABLE I

THE EFFECT OF ISCO BASE WSX-3 UPON THE STRENGTH PROPERTIES OF WEYERHAEUSER BLEACHED SULFITE PULP
(4500 grams plus balance weight and 743 cc. S.-R.)

ISCO Base, %	Alum Added, %	Basis Weight, 25x40/500	Mullen Burst, pts./100 lbs.	Tear Factor	M.I.T. Fold	Wet Schopper Tensile, lb./in.
0	0	43.4	57	1.34	77	0.4
5	4.5	46.7	61	1.33	73	1.2

DISCUSSION OF RESULTS

If alum had been used in the control, the burst would have been in the range of 54 pts./100 lbs. instead of the 57 pts./100 lbs. that was obtained without alum. The increase in burst without alum was 7%. If alum had been used, the increase in burst would have been 13%.

Weyerhaeuser bleached sulfite beaten to around 750 cc. Schopper-Riegler freeness has a Schopper Tensile, dry, of about 15 lbs./inch. This value was obtained from previous data on this pulp. Since there is not much of an increase in strength properties due to the addition of base, there probably was not much of an increase in the value after adding the base. The wet tensile value divided by the dry tensile value times 100 gives the per cent wet strength. Wet strengths aren't usually considered developed until they exceed 10%.

This base, WSX-3, has some properties of a beater additive, but probably does not warrant further study at this time.

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* 774	774	503
136-144	154-159	103-105

AN EXPERIMENTAL ATTEMPT TO PREVENT IRREVERSIBLE DEHYDRATION OF PULPS UPON DRYING

SUMMARY

There isn't a large enough difference between the undried and air-dried pulps to tell if there is any irreversible dehydration present. There undoubtedly is some irreversible dehydration present, but under conditions where the dried pulp would have been heat-dried, there would have been a decided difference.

The control for the treatment of the pulp with locust bean gum should have been drained of excess gum before it was beaten. The data show that before much fiber surface is developed, the gum-treated pulp that was air-dried had the same bursting strength vs. beating time curve as the undried pulp beaten with the locust bean gum.

Due to the lack of a large enough difference between the strength properties of the undried and air-dried pulps, it cannot be said whether the locust bean gum prevented irreversible dehydration or not.

INTRODUCTION

It appears possible that a sorbed gum or other high polymeric material having suitable properties may prevent irreversible dehydration of cellulose fibers. If the loss of strength of pulps upon drying is due to vander Waals or H-bonds which become so numerous or so completely formed that the energies involved in conventional beating and hydration are unable to disrupt them, perhaps prior diffusion of a more hydrophillic material may prevent irreversibility. These gums may become H-bonded to the cellulose structure and prevent the bonding (and possible ether formation) between fibers. Upon subjecting such treated fibers to beating the gum should enable the fiber to hydrate in a normal manner.

This experiment will be made with a southern pine kraft pulp which has not been previously dried.

1. A sample will be air-dried
2. A sample will be treated with 5% locust bean gum and then air-dried.
3. Two samples will be maintained in a moist state.

Beater runs will be made on the above pulps with suitable controls to determine the effect of the gum on rehydration (1).

EXPERIMENTAL

A moisture determination was made on the southern pine kraft pulp which showed that the pulp had 72.4% moisture. It would require 1312 grams of wet pulp to give 360 grams of oven-dry pulp.

A beater load of 360 grams oven-dry pulp was allowed to air-dry on a screen for several days. Two beater loads of pulp were stored in tightly sealed bottled and kept in their wet condition.

A beater load of pulp was suspended in 12 liters of water, making a 3% consistency pulp. This pulp mixture was stirred with a large Lightnin Mixer. To this pulp, 3600 grams of 0.5% locust bean gum dispersion was added, making 5% gum on the weight of the fibers. This gum-pulp furnish was stirred for several hours and allowed to stand overnight. The next day the pulp slurry was drained through a drain box and the pulp pressed in a small wine press to remove the remainder of the water. The pressed pulp was crumbed and placed on a screen to air-dry.

The locust bean gum dispersion was made by dusting 18 grams of unpurified locust bean gum into a tared beaker containing about one liter of distilled water. The gum and water were stirred while being cooked rapidly with steam injection. The dispersion was heated to 90° C. and kept there for 15 minutes. The dispersion was then diluted to 3600 grams, making a 0.5% locust bean gum dispersion.

A beater evaluation was made using one of the beater loads of undried pulp. The pulp was slushed for five minutes in the Valley Beater and then beaten to the following freeness levels where samples were taken for handsheets: 850, 800, 700, 600, and 400 cc. Schopper-Riegler. The bed plate load was 5500 grams plus the balance weight. The beating curve is in Table I.

TABLE I

BEATING CURVE OF UNDRIED SOUTHERN PINE KRAFT PULP
(5500 grams. Bed Plate Load)

Beating Time, min.	Schopper-Riegler Freeness, cc.
0	900
5	867 & 895
7	876
13	896
15	873
20	869
23	864
25	856 *
35	802 *
45	698 *
50	601 *
57	455
59	414 *

* Samples removed

A beater evaluation was made on the air-dried pulp. The pulp was soaked for four hours and beaten on the same day. The pulp was slushed for 5 minutes in theValley Beater and beaten to various freeness values with 5500 grams plus the balance weight on the bed plate. The freeness values were the same as before, i. e., 850, 800, 700, 600, and 400 cc. Schopper-Riegler. The beating curve is in Table II.

TABLE II

BEATING CURVE OF AIR-DRIED SOUTHERN PINE KRAFT PULP (5500 grams Bed Plate Load)

Beating Time, min.	Schopper-Riegler Freeness, cc.
0	878
9	880
15	879
25	859
26	869 & 867
28	861
30	857 *
40	801 *
50	683, 719, & 724
52	666 & 680 *
55	602 *
65	363 & 403 *

* Samples of pulp for handsheets taken

A beater evaluation was made on undried pulp with 5% locust bean gum in the beater. The other beater load of undried pulp was slushed for 5 minutes in the Valley Beater. During the slushing period, 5% of locust bean gum was added just in front of the beater roll. The pulp was beaten with 5500 grams plus the balance weight on the bed plate to the same freeness values as before. The beating curve is in Table III.

TABLE III

BEATING CURVE FOR UNDRIED SOUTHERN PINE KRAFT PULP WITH 5% LOCUST BEAN GUM IN THE BEATER

(5500 grams Bed Plate Load)

Beating Time, min.	Schopper-Riegler Freeness, cc.
0	869
5	880
10	879
15	879
20	878
25	863
26.5	863
28	861
30	856 *
40	777 & 787 *
45	719
46	690 *
48	652
50	610 *
59	405 *

* Samples of pulp for handsheets taken

A beater evaluation was made on the pulp that was gum treated and then air-dried. The pulp was soaked for four hours and then slushed for five minutes in the Valley Beater and beaten with 5500 grams plus the balance weight to the same freeness values as before. The beating curve is in Table IV.

TABLE IV

BEATING CURVE FOR GUM TREATED AND AIR-DRIED SOUTHERN PINE KRAFT PULP
(5500 gram Bed Plate Load)

Beating Time, min.	Schopper-Riegler Freeness, cc.
0	885
5	890
10	900
15	893
20	880
25	869
28	864
31	860
32	860
33	863 & 862
35	853 *
40	839
45	816
46	806 *
52	780 & 773
55	734
57	723
60	678 *
68	584 *
75	470
79	420
81	376 *

* Samples taken for handsheets.

The handsheet data for the beater evaluations are found in the following tables:

TABLE V

HANDSHEET DATA FOR BEATER EVALUATION OF SOUTHERN PINE KRAFT PULP - UNDRIED
849-I

(5500 grams Bed Plate Load)

Beating Time, min.	Schopper-Riegler Freeness	Basis Weight	Mullen Burst, pts./100 lb.	Tear Factor	M.I.T. Fold	Schopper Tensile lb./in.
25	856 cc.	47.9	80	2.99	450	20.0
35	802 cc.	45.0	88	2.64	531	19.4
45	698 cc.	45.1	97	2.31	667	21.7
50	601 cc.	46.5	102	2.19	810	21.7
59	414 cc.	43.6	100	2.06	702	24.2

TABLE VI

HANDSHEET DATA FOR BEATER EVALUATION OF SOUTHERN PINE KRAFT PULP -
AIR DRIED 849-II

(5500 grams Bed Plate Load)

Beating Time, min.	Schopper-Riegler Freeness	Basis Weight	Mullen Burst, pts./100 lb.	Tear Factor	M.I.T. Fold	Schopper Tensile lb./in.
30	857 cc.	54.2	79	3.10	240	20.9
40	801 cc.	40.2	86	2.69	259	18.3
52	666 cc.	46.9	94	2.30	399	23.3
55	602 cc.	45.1	98	2.33	393	24.3
65	403 cc.	45.0	101	2.09	480	23.1

TABLE VII

HANDSHEET DATA FOR BEATER EVALUATION OF SOUTHERN PINE KRAFT PULP - UNDRIED AND BEATEN WITH 5% LOCUST BEAN GUM IN THE BEATER. 849-III (5500 grams Bed Plate Load)

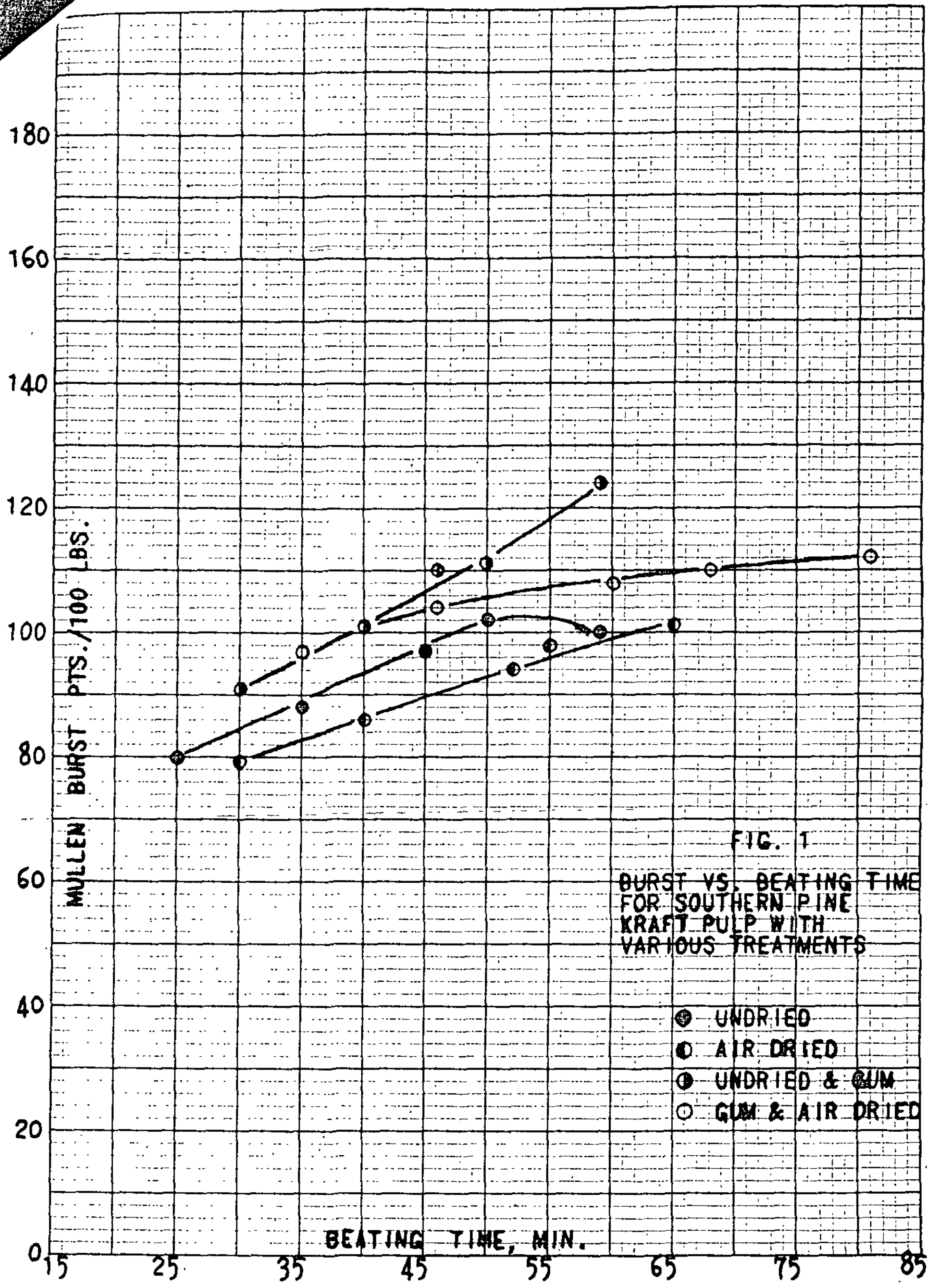
Beating Time, min.	Schopper-Riegler Freeness	Basis Weight	Mullen Burst pts./100 lbs.	Tear Factor	M.I.T. Fold	Schopper Tensile lb./in.
30	855 cc.	45.2	91	2.28	412	18.6
40	780 cc.	46.1	101	2.00	488	23.4
46	690 cc.	45.7	110	1.88	661	24.8
50	610 cc.	44.0	111	1.80	665	24.6
59	405 cc.	44.2	124	1.70	758	25.7

TABLE VIII

HANDSHEET DATA FOR BEATER EVALUATION OF SOUTHERN PINE KRAFT PULP - 5% LOCUST BEAN GUM TREATED AND AIR DRIED BEFORE BEATING
849-IV (5500 grams Bed Plate Load)

Beating Time, Min.	Schopper-Riegler Freeness	Basis Weight	Mullen Burst pts./100 lbs.	Tear Factor	M.I.T. Fold	Schopper Tensile lb./in.
35	855 cc.	44.3	97	2.26	319	21.6
46	805 cc.	43.9	104	2.12	406	22.9
60	680 cc.	43.0	108	1.88	540	24.5
68	585 cc.	44.2	110	1.81	619	24.7
81	375 cc.	43.7	112	1.58	668	26.6

The data for the burst and tear are shown in Figures 1 and 2.


MULLEN BURST PTS./100 LBS.
0
20
40
60
80
100
120
140
160
180
BEATING TIME, MIN.
15
25
35
45
55
65
75
85
FIG. 1
BURST VS. BEATING TIME FOR SOUTHERN PINE KRAFT PULP WITH VARIOUS TREATMENTS
UNDRIED
AIR DRIED
UNDRIED & GUM
GUM & AIR DRIED

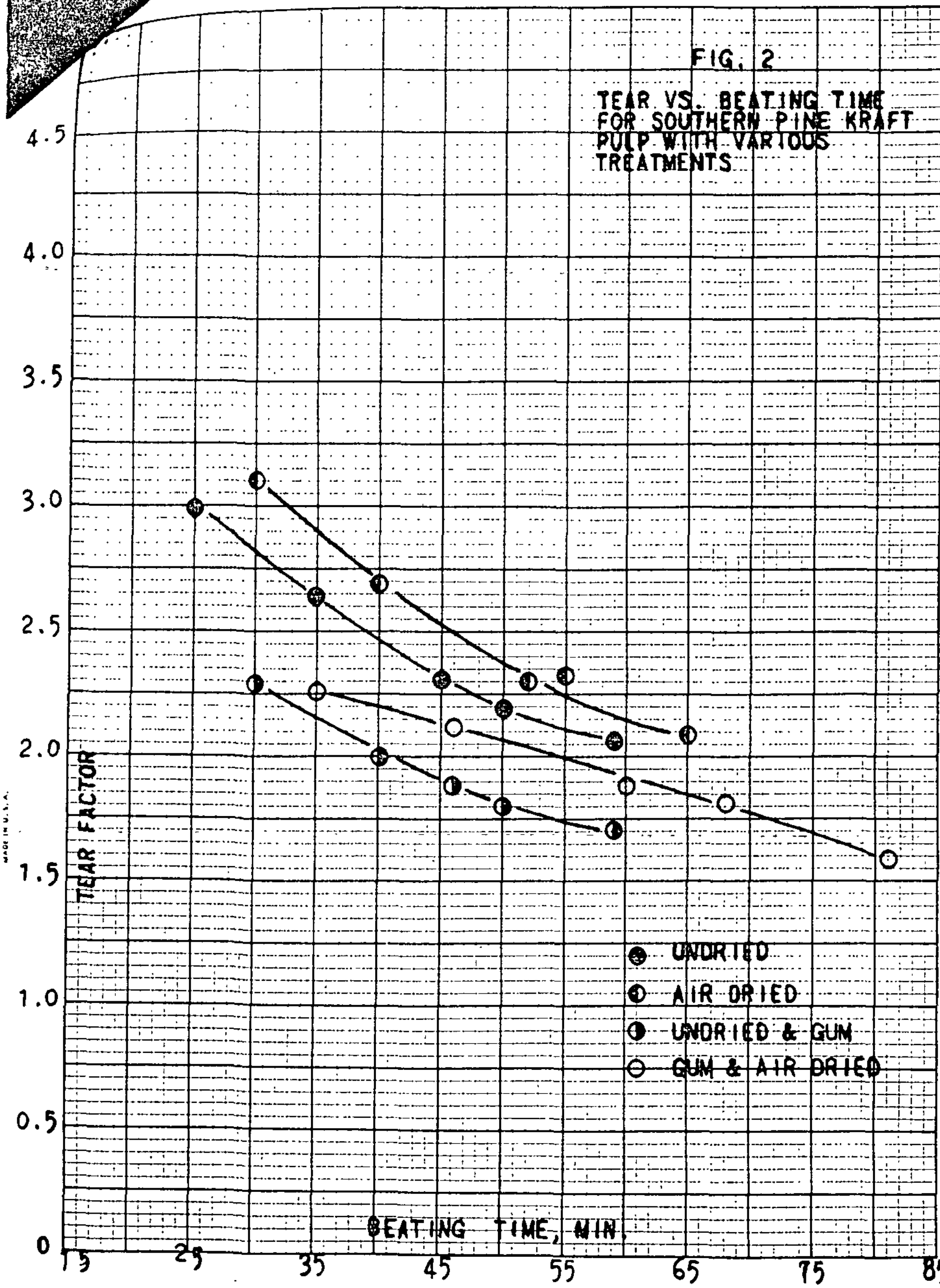


FIG. 2
TEAR VS. BEATING TIME FOR SOUTHERN PINE KRAFT PULP WITH VARIOUS TREATMENTS
TEAR FACTOR
BEATING TIME, MIN.
0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
15
25
35
45
55
65
75
85
UNDRIED
AIR DRIED
UNDRIED & GUM
GUM & AIR DRIED

DISCUSSION OF RESULTS

Drying the pulp doesn't seem to change the bursting properties of the southern pine kraft pulp, but the drying shifts the beating curve so that the pulp must be beaten longer to attain the same strength.

Beating the undried pulp with 5% locust bean gum in the beater takes a little longer to beat to the same freeness as the undried pulp alone, but the bursting strength is much greater. The bursting strength of the undried pulp plus the gum after 40 minutes of beating, is equivalent to the bursting strength of the undried pulp alone after 50 minutes of beating. There seems to be a maximum in the bursting strength for the undried pulp of 102 points/100 lbs. between 50 to 55 minutes of beating. On the contrary, the undried pulp beaten with the gum had a value of 124 points per 100 lbs. at 59 minutes, and seemed to be still going higher.

Treating the pulp with 5% locust bean gum and then air drying before beating caused the pulp to take longer times of beating to reach the same freeness values as the undried pulp. However, it took shorter times of beating to reach the same bursting strength as the undried pulp. It took 35 minutes to beat the gum-treated pulp to the same bursting strength of the undried pulp which took 45 minutes of beating. The bursting strength of the gum-treated pulp does not have a steep slope when plotted against the beating time. This is explained by the fact that the pulp was drained before drying, which allowed all the excess gum not absorbed, to excape. With the increase in fiber surface with beating, no more strength was obtained because there was no excess gum left to be adsorbed by this new surface.

In the case of the undried pulp beaten with 5% locust bean gum, the gum was in the beater as the fiber surface increased, allowing more gum to be adsorbed. This accounts for the steep slope of the curve obtained by plotting the butsting strength against the beating time.

This work should possibly be repeated with some other pulp. The drying of the pulp should be done with a little heat so that there will be a much greater difference between the undried and dried pulp. The gum-treated pulp could be worked up the same as before. The undried pulp should be treated with gum and drained and then beaten before drying to give a control for the pulp beaten with gum. Draining the pulp before beating would get rid of the excess gum so that this experiment would be comparable to the gum-treated pulp and air-dried before beating.

It may be a good thing to beat this pulp as received to a Schopper-Riegler freeness of 800 cc. before any experiments are tried. This would break and open up the fibers for the first time since they were cooked and washed.

REFERENCES

(1) Introductory remarks made by John Swanson
Project 849, Notebook 774, pp. 138-139

RCM/jhh

PROJECT REPORT FORM

PROJECT NO. 849
COOPERATOR Institute
REPORT NO. 25
DATE February 22, 1950
NOTE BOOK 774
PAGE 145 TO 153
SIGNED Russell C. Morse
Russell C. Morse

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AN EXPERIMENT TO DETERMINE IF SODIUM PALCONATE AND SODIUM PALCOSULFONATE CAN BE USED AS BEATER ADDITIVES

SUMMARY

Although there didn't seem to be any adsorption of sodium palcosulfonate when a sample of filtrate was checked for transmission of light, there was a greater increase in the strength properties of the Weyerhaeuser bleached sulfite with the sodium palcosulfonate than with the sodium palconate which did indicate that adsorption had taken place. The sodium palcosulfonate increased the burst 19.3%, while the sodium palconate increased the burst 9.6%.

When alum is added to the sodium palconate and sodium palcosulfonate pulp furnishes, there was no increase in burst in the case of the palconate. The sodium palcosulfonate and alum gave an increase of 9.1% in burst.

Sodium palcosulfonate which gave the best strength improvements probably wouldn't be suitable as a beater additive because it takes 10% on the fiber to give an increase of 19% in burst.

INTRODUCTION

Work carried on by the Plastics Department of the Institute indicated that sodium palconate and sodium palcosulfonate may be suitable as beater additives for the making of dark colored papers. The present experiments were performed to investigate this possibility.

EXPERIMENTAL

A calibration curve for sodium palconate was made by preparing a solution of known concentration of sodium palconate (.5 g./l.) and making a dilution to .1 g./l. These solutions were put into cells and placed in the I.P.C. Photolometer to have their transmissions read. The standard solution was distilled water. The data are in Table I and Figure I.

TABLE I

CALIBRATION CURVE FOR SODIUM PALCONATE

Concentration of Palconate	Transmission, %
0	100
0.1 g./l.	78
0.5 g./l.	29

A similar calibration curve was prepared for sodium palcosulfonate. The data are in Table II and Figure I.

TABLE II

CALIBRATION CURVE FOR SODIUM PADCOSULFONATE

Concentration of Palcosulfonate	Transmission, %
0	100
0.1 g./l.	80
0.5 g./l.	34

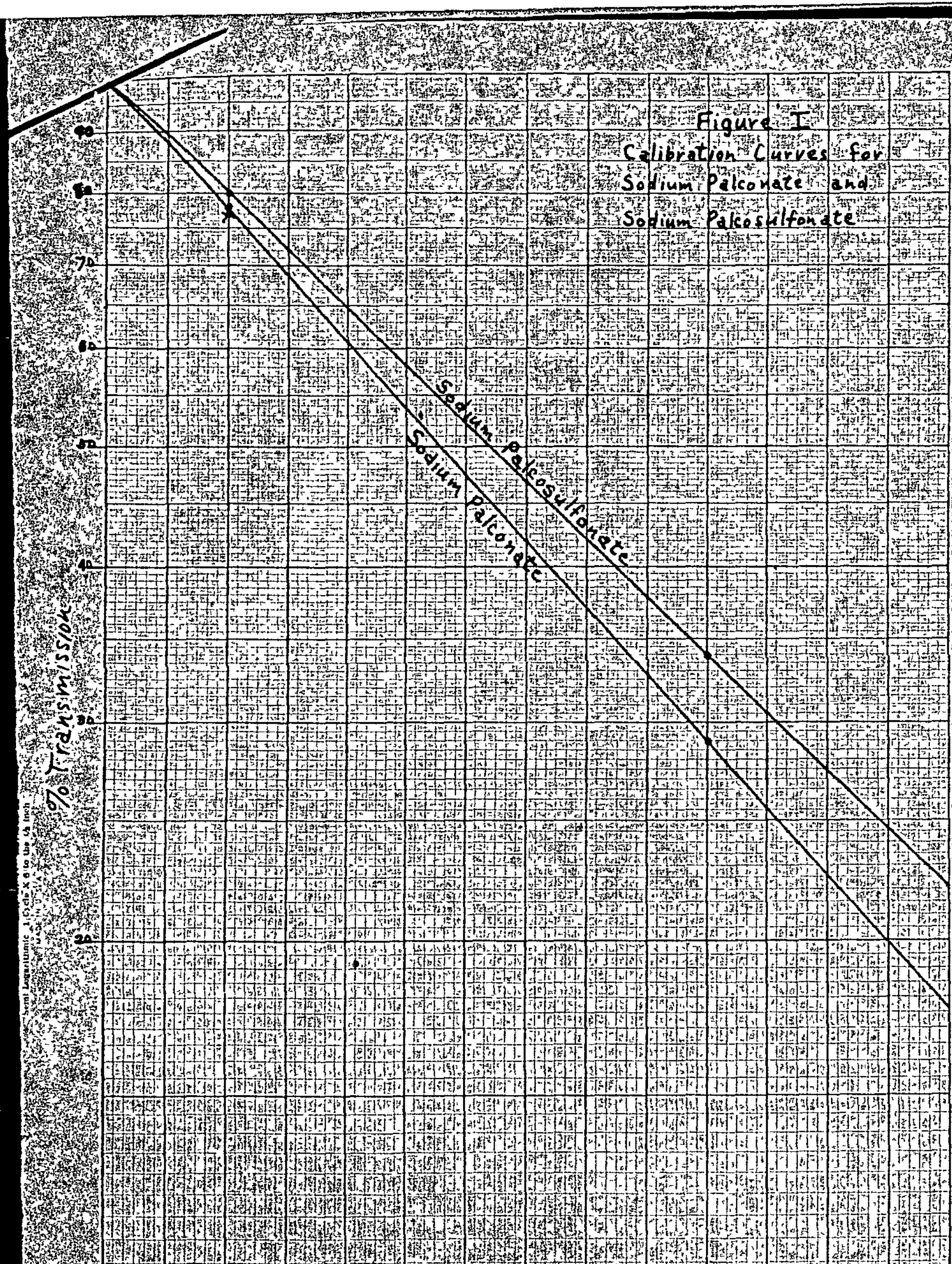

Figure I
Calibration Curves for
Sodium Palconate and
Sodium Palcosulfonate
Sodium Palcosulfonate
Sodium Palconate
% Transmission
Concentration g/l.
90
80
70
60
50
40
30
20
10
0
1
2
3
4
5

Sodium palconate (200 ml. of .5 g./l.) was added to 100 mls. of 1.55% consistency Weyerhaeuser bleached sulfite pulp. The pulp furnish was diluted to 1 liter and stirred for 1 hour. This is about 10% palconate based on the fibers. A sample of filtrate was removed from the pulp slurry by vacuum through the bottom of a medium-porosity, sintered-glass crucible. The sample was then read for per cent transmission. The concentration of the palconate in the slurry was .1 g./l. If no palconate is adsorbed, the transmission of the filtrate would be the same as before (78%). The transmission of the filtrate read 85% which corresponds to .0562 g./l. This difference in the transmission figures to be 43.8% adsorption.

A similar experiment was carried out using sodium palcosulfonate. The concentration of the palcosulfonate was .1 g./l. If no adsorption took place, the transmission should be 80%. The transmission of the filtrate read 81%. This transmission is too close to the original for .1 g./l. to be due to adsorption.

Moisture determinations were made on these two compounds. The sodium palconate had 9.57% moisture, while the sodium palcosulfonate had 5.21%.

A stock solution of sodium palconate was made by dissolving 6.01 g. (oven dry) in 1 liter of water. A stock solution of sodium palcosulfonate was made by dissolving 6.00 g. (oven dry) in 1 liter of water.

Weyerhaeuser bleached sulfite (377 g. air dry) was slushed for 5 minutes in the Valley Beater after a minimum of 4 hours soaking.

The pulp was beaten to 765 cc. Schopper-Riegler freeness in 21 minutes using 5500 grams plus the balance weight on the bed plate.

Twenty-five grams of pulp were diluted to 5 liters and handsheets were made.

Twenty-five grams of pulp were diluted with 250 mls. of 2 1/2 % alum (25% alum based on the fibers) and diluted to 5 liters. The alum was added to the pulp around 1% consistency and stirred for 5 minutes before diluting to 5 liters. Handsheets were made keeping the pH between 4.5-5.0 in the sheetmold by adding sulfuric acid.

Twenty-five grams of pulp were diluted to 1% consistency and 417 ml. of 6 g./l. sodium palconate (2.5 g.) were added and stirred for 1 hour. The pulp slurry was diluted to 5 liters (0.5% consistency) and handsheets were made.

Twenty-five grams of pulp were diluted to 1% consistency and 417 mls. of 6 g./l. sodium palconate (2.5 g.) were added and stirred for 1 hour. Alum (250 mls. of 2 1/2 %) was added and stirred for 5 minutes. The pulp furnish was diluted to 5 liters and handsheets were made keeping the pH between 4.5-5.0 in the sheetmold by adding sulfuric acid.

Two sets of handsheets using sodium palcosulfonate instead of sodium palconate were made just like those above.

The handsheets containing 10% sodium palconate were a slight pink, while those containing the palconate and 25% alum were so brown as to resemble unbleached kraft paper.

The handsheets containing sodium palcosulfonate were about the same in appearance as the palconate except that the sheets containing palcosulfonate and alum were not as dark as those with palconate and alum.

These two salts had the following effects on the freeness: (Table III)

TABLE III

THE EFFECTS OF SODIUM PALCONATE AND SODIUM PALCOSULFONATE UPON THE SCHOPPER-RIEGLER FREENESS

Handsheet Sets	Alum, %	Sodium Palconate, %	Sodium Palcosulfonate, %	Schopper-Riegler Freeness cc.
1	--	--	--	764
2	25	--	--	764
3	--	10	--	751
4	25	10	--	634
5	--	--	10	745
6	25	--	10	661

The handsheet data are in Table IV.

TABLE IV

THE EFFECT OF SODIUM PALCONATE, SODIUM PALCOSULFONATE, AND ALUM UPON THE STRENGTH PROPERTIES OF WEYERHAEUSER BLEACHED SULFITE
(765 cc. S.R. and 5500 grams bed plate load)

Sodium Palconate, %	Sodium Palcosulfonate, %	Alum, %	Basis Weight	Mullen Burst pts./100 lbs.	Elmendorf Tear g./sheet	Tear Factor	Tappi Size sec.
0	0	0	43.9	52	62	1.41	Instantaneous
0	0	25	42.8	55	61	1.43	Instantaneous
10	0	0	44.8	57	63	1.41	Instantaneous
10	0	25	42.7	55	56	1.31	Instantaneous
0	10	0	44.2	62	64	1.45	Instantaneous
0	10	25	43.0	60	64	1.49	Instantaneous

DISCUSSION OF RESULTS

The alum alone increases the burst and tear slightly. The burst is increased 5.8%.

The sodium palconate increases the burst while the tear remains the same. The increase in burst was 9.6%. When alum was added to the sodium palconate, the burst was not affected and the tear decreased 8.4%.

The sodium palcosulfonate increases the burst 19.3% and increases the tear 2.3%. When alum is added to the sodium palcosulfonate, the burst is increased only 9.1%, but the tear is increased 4.2%.

There is no sizing effect due to the sodium palconate or the palcosulfonate.

Even though there didn't seem to be any adsorption of sodium palcosulfonate when a sample of filtrate was checked for transmission of light, there was a greater increase in the strength properties of the sulfite pulp with the sodium palcosulfonate than with the sodium palconate which did indicate that adsorption had taken place.

The quantity of alum added was much greater than that usually added. It took that much alum to lower the pH to 4.5-5.0. It may be better to add only 2.5 or 3% alum to the pulp and lower the pH to 4.5-5.0 with sulfuric acid.

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PROJECT REPORT FORM

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A TECHNIQUE FOR INVESTIGATING THE ADSORPTION OF BEATER ADDITIVES

INTRODUCTION

The proposed method of studying adsorption of carbohydrate beater additives on pulp is the addition of a known amount of additive and the analysis of the white water for the unadsorbed portion. An article entitled "Quantitative Determination of Carbohydrate with Dreywood's Anthrone Reagent" by Morris in Science, March 5, 1948, described a method which seemed applicable in such a study.

EXPERIMENTAL

I. Method for Carbohydrate Analysis:

Five ml. of the solution to be analysed for carbohydrate are pipetted into a 1" x 8" test tube. (The size is critical because the heat produced enables the reaction to proceed.) Then ten ml. of Dreywood's Anthrone reagent are added and the layers thoroughly mixed by swirling until no concentration lines are visible. (The reagent is prepared by dissolving one gram of Anthrone in 500 ml. of 95% sulfuric acid.) The mixture is allowed to stand for ten minutes and then compared to a similarly prepared mixture of distilled water and reagent in a Cenco-Sheard-Sanford Photolometer with a No. 26 Wratten filter. This procedure has been followed in every case and is the basis of all following experiments.

II. Calibration of the Method for Guar Gum:

The preparation of standard guar dispersions for the purpose of calibrating the above procedure was done in the following manner:

2.500 g. of purified G42 were added to approximately 400 ml. of distilled water contained in a tared flask. The mixture was brought to 85-90° by indirect steam and stirred until there were no lumps. The dispersion was then diluted to 500 grams, heated again to 85°, and stirred for 10-15 minutes. This made a dispersion of .5% guar. From stock solutions prepared in this manner, all further dilutions were made by weight.

The analysis of known dilutions of such a stock solution ranging from .1 to .000001% in guar concentration indicated that the practical range of the method was from .01% to .002%. Within the range the plot of concentration against the logarithm of the per cent transmission gave a straight line through the origin. This plot has been used as a calibration curve.

During the first several weeks of the work, .01%, .008%, .005%, and .002% guar solutions were made frequently and analyzed with Dreywood's reagent. Each day's curve was used for calculating any other analysis completed during that day. The agreement between curves made it possible to average all the data taken from 6/16/48 to 7/1/48 and draw a standard calibration curve. This data is tabulated in Table I and plotted in Figure 1.

For convenience in this work a new unit of gum concentration was defined: Gamma (γ) denotes the concentration of gum in millionths of a gram per 100 cc. In future work this unit should probably be changed since it tends to indicate more significant figures than are justified by the method.

TABLE I

PHOTOLOMETER TRANSMISSION DATA FROM WHICH AVERAGE GUAR CALIBRATION CURVE WAS CALCULATED
(See Figure 1)

Date	% Transmission			
Concentration of Guar	10,000 γ .01%	8,000 γ .008%	5,000 γ .005%	2,000 γ .002%
6/16	28.0	35.0	51.0	75.6
6/17	29.8	36.0	51.6	74.2
6/18	26.9	35.9	52.5	73.2
6/18	26.8	34.0	52.7	75.2
6/21	28.0	35.8	50.6	75.0
6/22	29.6	37.2	53.0	77.2
6/26	30.0	37.8	53.0	78.9
6/30	30.2	37.2	54.0	76.0
7/1	34.0	37.1	53.4	78.0
Average	29.2	36.2	52.4	75.9

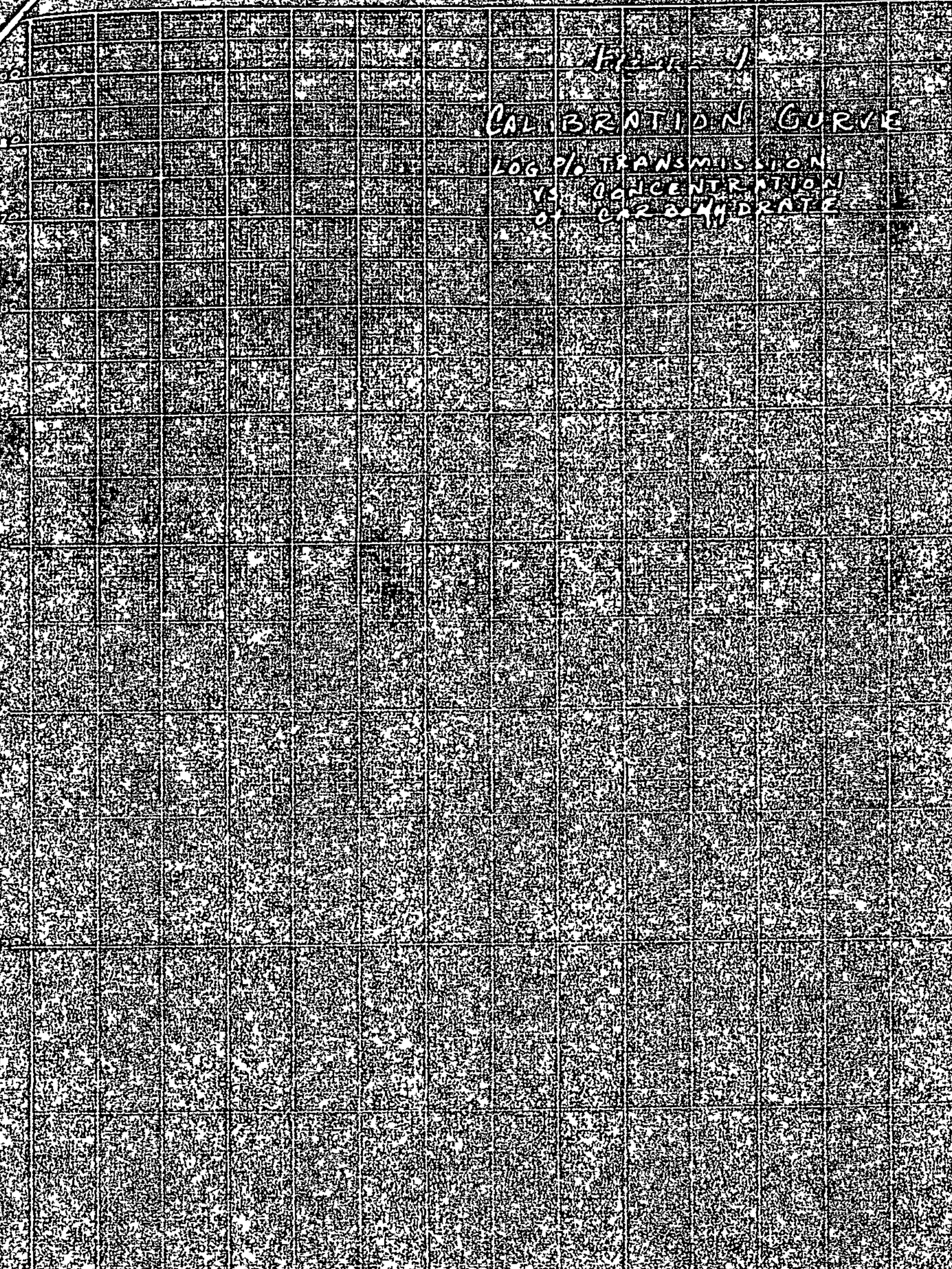

Figure 1

CALIBRATION CURVE

LOG % TRANSMISSION
VS CONCENTRATION
OF CARBOHYDRATE

III. Determination and Elimination of the Blank

Weyerhaeuser bleached sulfite pulp was beaten in a Valley beater at 1.5% consistency with the balance weight and 4500 grams for 30 minutes to a Schopper-Riegler freeness of approximately 800 cc. This beating procedure has been used throughout the work.

The analysis of white water for additive concentration requires either complete removal of cellulose from the white water or determination of a cellulose blank. A preliminary experiment with unbeaten pulp indicated appreciable cellulose material was apparently dissolved from the fiber. After filtratiön of the pulp on coarse fritted glass, the dissolved material in the filtrate gave transmission as low as 70% when analyzed with anthrone.

Repeated filtration and suspension of the pulp largely removed the cellulose blank (transmission 98.6%) after 7 to 10 filtrations through the same uncleaned filter. But if the same pulp which had been extracted ten times was resuspended and filtered through a freshly cleaned filter, the transmission went to 81.8%. This indicates that the apparently soluble cellulose material was being continually dispersed from the fiber by succeeding suspensions and that the more complete removal was due to the plugging of the filter.

To simulate the plugged filter a 1/4" pad of Celite Analytical Filter Aid was made on the glass filter funnel by sucking a distilled water slurry of celite through the clean filter. White water which gave 87% transmission when filtered through fritted glass alone gave 97% when filtered through such a celite pad. This was further improved by extracting the pulp twice with distilled water before filtration. Three aliquots removed at different times during the celite filtration gave transmissions of 99.8%, 100%, and 98.6%, indicating almost complete removal of the cellulose blank.

To determine the effect of the celite filtration on the concentration of guar gum, a calibration curve was made using dilutions which had been filtered through celite pads giving the following results.

TABLE II

CALIBRATION CURVE AFTER CELITE FILTRATION

Concentration in γ	% Transmission
10,000	26.9
8,000	35.9
5,000	52.5
2,000	73.2

A plot of the above data coincides with the standard calibration curve within experimental error.

The filtration through a glass filtering funnel necessarily changed the temperature of the sample. For convenience of removing the white water sample from the pulp water mixture, the sample was pulled up through the bottom of a fritted glass crucible, corked, and connected to a Hy vac suction pump. It was possible to make a celite pad 8 mm. thick on the underside of these crucibles which, after being pressed under suction and baked at 140°,C., would remain intact during the filtration. Six different crucibles were prepared in this manner and used to filter freshly beaten and extracted pulp. The transmissions of the blanks are given in Table III.

TABLE III

TRANSMISSION DATA FOR CELLULOSE BLANK AFTER CELITE FILTRATION

Crucible	% Transmission
I	87.2
II	87.5
III	87.8
IV	88.0
V	91.0
VI	86.0

With the exception of the fifth sample, the results agree within the precision of the standard calibration curve.

In later experiments, two samples were filtered and analyzed in every case. These analyses usually agreed within .5% transmission.

IV. The Effect of Temperature on Adsorption of Guar Gum on Cellulose Fiber

The general procedure for studying the effect of temperature on this adsorption was as follows: a one-liter sample of 1% consistency Weyerhaeuser bleached sulfite pulp, beaten as above, was brought to a given temperature in a bath regulated by a Cenco-Dekotinsky thermo regulator. Then 200 ml. of .1% gum which itself had been brought to temperature was added slowly. After stirring the sample for 15 minutes, two aliquots were removed by the above sampling technique and analyzed. The following table includes the data of those experiments conducted after the development of the crucible sampling technique. The last column of symbols denotes those groups which were run on the same day. This grouping indicates that the effect of temperature on guar adsorption is smaller than can be detected by the present technique.

TABLE IV

EFFECT OF TEMPERATURE ON GUAR ADSORPTION

Temperature, ° C.	% Gum Adsorbed on Weight of Gum Added	Group
20	39.1	*
30	30.5	✓
40	41.2	*
50	30.1	✓
50	32.8	0
60	38.2	*
60	28.1	0

V. Effect of Gum to Pulp Ratio on Adsorption of Guar by Cellulose

Enough .1% guar dispersion was added to five one-liter samples of 1% consistency pulp to give .25%, .5%, 1.0%, and 2.0% gum on pulp. Distilled water was added to the samples so that the final volume was the same in every case. After stirring for five minutes, three 5-ml. samples were removed with celite-padded crucibles and analyzed for carbohydrate. The percentage of gum adsorbed by the pulp was calculated. The results are tabulated in Table V and plotted in Figure 2. The experiment was repeated on another day. Both results are indicated.

TABLE V

GUM ADSORBED AT VARIOUS GUM TO PULP RATIOS
1% Consistency Pulp

% Gum on Pulp	% Gum Adsorbed on Concentration Added	
	1st Run	2nd Run
.25	92.4	95.3
.50	70.6	64.0
1.0	48.6	39.9
2.0	41.4	33.2
3.0		28.0

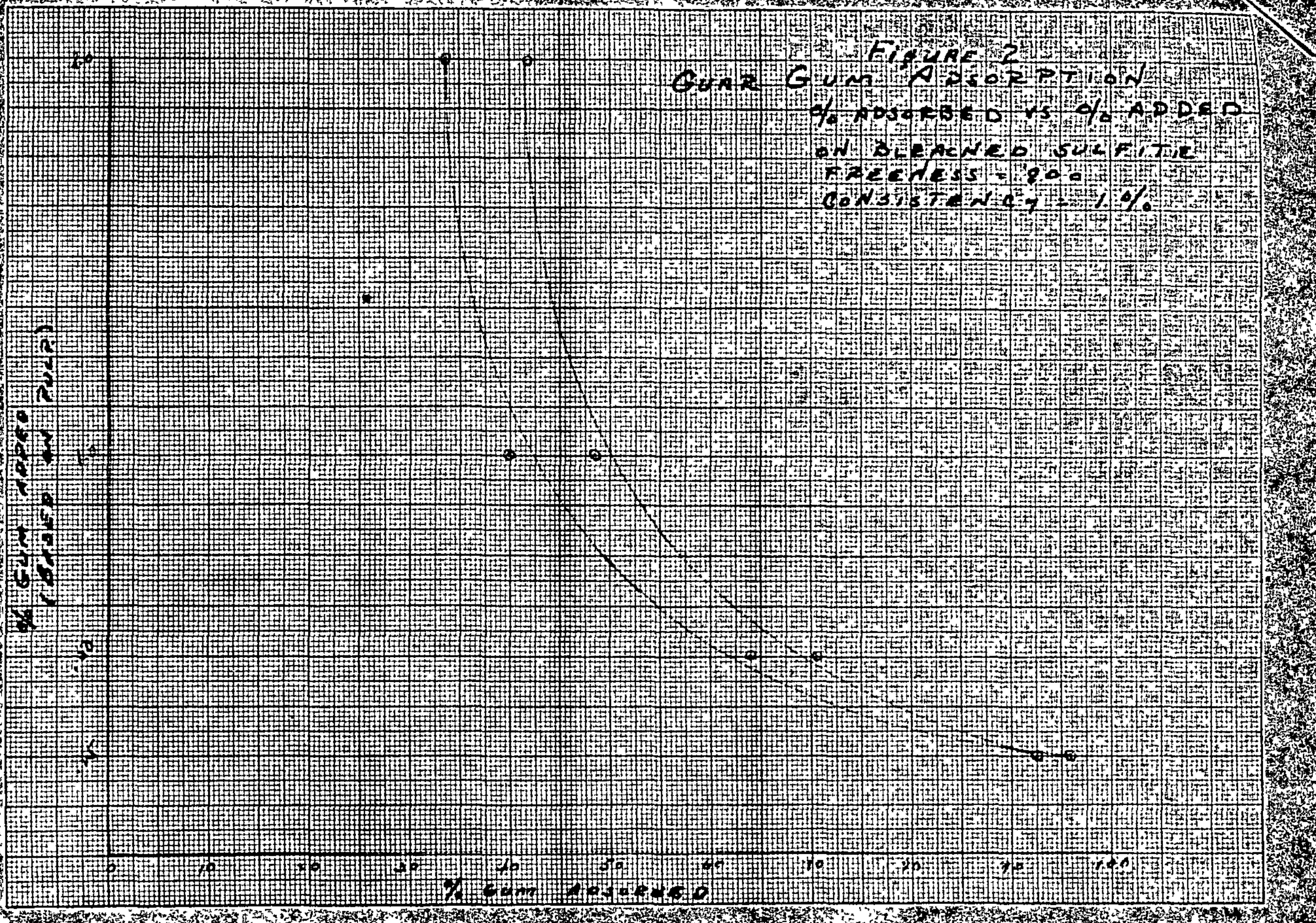
FIGURE 2
GUAR GUM ADSORPTION
% ADSORBED VS % ADDED
ON BLEACHED SULFITE
FREENESS - 800
CONSISTENCY - 1%
% GUM ADDED (BASED ON PULP)
% GUM ADSORBED
0
10
20
30
40
50
60
70
80
90
100

VI. The Effect of Pulp Consistency on Adsorption of Guar Gum

To study the effect of dilution over a 10-fold range and yet not work at extremely small concentrations, the pulp preparation was changed. After normal beating and two distilled water extractions, the pulp was pressed and crumbed and its moisture content determined. Enough pulp was added to gum and water to make a mixture at 10% consistency with 2% gum on pulp. This was stirred and allowed to stand one half hour. The sample was split in two equal parts. From one part, aliquots for analysis were taken with filtering crucibles. The other half was diluted to 5% consistency. This procedure was repeated again diluting to 1% consistency. Calculation of the percentage of gum adsorbed gave results tabulated in Table VI. The entire experiment was repeated at 1% gum on pulp.

TABLE VI

EFFECT OF DILUTION ON ADSORPTION

Pulp Consistency, %	% Gum Adsorbed Based on Total Gum Added 2% Gum on Pulp	1% Gum on Pulp
10	42.5	55.0
5	55.5	68.0
1	60.6	70.0

These data indicate greater adsorption at lower concentrations. However, the variation may be due to better agitation, at lower consistencies.

VII. Miscellaneous Experiments

Experiments were tried with different fibers including cotton, rag, hardwood, sulfite, bleached kraft, Hercules cotton, ashless filter paper and viscose rayon. In every case there was a cellulose blank.

Several experiments were made with methocel. These are found on page 65 of Notebook 774.

The experiment described above (Part V) in which the gum to pulp ratio was varied was repeated at 0.1% consistency. The calculation indicated that the concentration of carbohydrate remaining after addition of gum was greater than the sum of the gum added and the pulp blank. The results are given in Table VII.

TABLE VII

APPARENT INCREASE IN BLANK UPON GUM ADDITION

% Gum on Pulp	Concentration Added, in γ	Concentration Remaining After Subtraction of Cellulose Blank (in γ)
0.25	208	170
0.5	416	420
1.0	833	1020
2.0	1670	2170

This would indicate an increased dispersion of apparently soluble cellulose material caused by addition of gum. This variability of the blank would affect all previous work to some extent and should be studied further.

It would seem that the most likely solution to the problem is a change to a different fiber having little or no apparently soluble carbohydrate material.

mbw/mmm