6-1955

The Effect of Various Deinking Solutions and Concentrations Upon the Strength of Fiber

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"THE EFFECT OF VARIOUS DEINKING SOLUTIONS AND CONCENTRATIONS UPON THE STRENGTH OF FIBER."

Submitted as partial fulfillment of the requirements for graduation in the curriculum of Pulp and Paper Technology at Western Michigan College of Education. Kalamazoo, Michigan.

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June, 1955

ABSTRACT

Preliminary investigation produced limited information on the effect of various deinking solutions and concentrations upon the strength of fiber. Experimentation indicated that deinking does have a destructive effect upon the strength of fiber. This effect correlates to the temperature and the amount of chemical used. Also indicated is the fact that a mixture of Sodium hydroxide and Sodium carbonate has less of a destructive effect than either of these alone.

INTRODUCTION

Much has been written about the different deinking systems in use at present. New methods of operation are constantly being discovered and new chemicals being used. With all this, an important aspect of deinking has been neglected. This is the effect of the different deinking solutions upon the strength of chemical wood fibers. The strength is influenced not only by the chemicals and their concentration, but also by the temperature at which the deinking is carried out and the length of time which the fibers are in contact with the deinking chemicals. It is this aspect with which this report is concerned.

THE EFFECT OF VARIOUS DEINKING SOLUTIONS & TEMPERATURES UPON THE STRENGTH OF CHEMICAL WOOD FIBERS

DEINKING

In theory the deinking of paper is a very simple process. In practice the operation is complicated by the fact that after paper is made and printed it resists being returned to its original form.

When paper is placed in water it may be partially broken up by subjecting it to mechanical action which causes paper particles to rub hard enough so that they are reduced to a pulpy mass. However complete reduction of the paper to pulp cannot be obtained without adding something to the water suspension that will break the bonds between the fiber and filler or coating and the ink. In addition once these bonds are broken these particles must be emulsified and a repelling action set up to prevent their redepositing and permit their easy removal.[1]

HISTORY OF DEINKING

The first part of the nineteenth century brought a rapid developement in the use of paper machines with a consequent reduction in paper manufacturing costs and increased paper consumption.[2] As rags were still the

chief papermaking raw material and the amount of them was limited, some thought was given to the use of waste paper in the manufacture of the better grades of paper. Work was started during the latter half of the eighteenth century in Germany and in 1800, Matthias Koops, using pearl ash as a deinking agent established a deinking system in an English mill.[2] Credit is given to Henry E. Rogers as the first papermaker to put a deinking system into operation in the United States. This installation probably dates back to about 1849.[2]

The development of mechanical and chemical wood pulps during the latter half of the nineteenth century gave added impetus to paper consumption and to an increase in use of waste paper.

During the early part of the nineteenth century there was a tremendous growth in the Canadian newsprint industry. Many of the older mills in the United States were forced by this competition into the manufacture of better grades of paper, and it was during this period that the deinking of paper had its greatest advancement. This advancement was accentuated during and after World War I, when wood pulp prices soared.

ADVANCEMENT IN THE ART

In 1801, Matthias Koops stated that his invention was a great success and he was producing more than 700

reams of perfectly clean and white paper. Present tonnage figures are not available but with the aid of modern methods and equipment there are mills able to produce 100 tons per day. From 1801, to date, there have been an untold number of systems invented and tried out, most of which use alkalies and soaps to loosen the inks from the fiber.

At the beginning of the century in this country, the only practical deinking systems in use were on waste paper groundwood-free and in which soda ash and caustic soda were the detergents.[2] This conditions applies today with a few exceptions and these exceptions have been due to the recent development in the chemical field of new wetting agents and detergents. As a result, a distinctive improvement in deinking should be anticipated.

ADVANTAGES OF DEINKED STOCK

Deinked paper serves as an economic substitute for virgin pulps, depending upon geographic and market conditions. Many mills located in or near large population areas find deinked stock much cheaper than virgin pulps.

Deinked stock decreases bulk. This is desirable in book, magazine and writing papers. It is these

papers in which deinked stock finds its greatest application.

Opacity is increased by the use of deinked stock. This is also important in the above paper fields.

Formation may be better since deinked stock has a relatively low freeness. This results in a well closed, dense and fairly snappy sheet.

With the use of deinked stock a higher percentage of size and filler can be retained in the sheet.

The cost of a deinking installation is relatively low compared to a chemical pulp mill.

THE LIMITATION OF DEINKED STOCK

Mr. O'donoghue states that the strength is generally decreased due to the reworking of the fibers.[3] It is the purpose of this report to see if this is actually the case and if this is true, to what degree the strength is affected.

TYPES OF DEINKING PROCESSES

There is no uniformity of operation in different deinking mills.[4] The equipment used depends upon the availability of floor space and equipment.[4] All deinking processes operate on the same basic principles. The first major operation is mechanical disintegration

and treatment with chemicals at high temperatures. There are two different classes of systems used in deinking, low density (4 to 9%) and high density (25 to 35%).[4]

Low Density Systems

The low density system is used by a majority of the mills. In this system the stock is mixed with water and deinking chemicals in a centrifugal pulper, breaker beater, or some other disintegrating device. The initial disintegration may be either a batch or continuous process.

In most cases the initial disintegration is followed by cooking in either cooking chests or stationary cookers. The temperature range is 160-210 degrees F. A complete cycle lasts from 2-5 hrs. depending upon equipment, concentration, temperature, chemicals used, and grades of waste paper.[4]

High Density Systems

High density disintegration is used to a limited extent. In this type of system the waste paper is fed together with the chemicals, water and steam into a pulper of the Lannoye type. The waste paper is disintegrated and deinked while in the pulper and is discharged continuously. High density disintegration may

be followed by low density cooking. Some mills still use cylindrical or rotary digesters for cooking waste paper. In these the dry paper is fed into the cookers together with hot water and chemicals. The waste paper is cooked under a pressure of from 15-30 pds. for a period of from 3-8 hrs.[4]

CHEMICALS USED IN DEINKING

The chemicals used in the deinking of printed papers usually comprise alkalies such as caustic soda, soda ash, or sodium phosphate together with surface active chemicals employed as wetting agents and detergents.[3] The alkalies break the fiber bonds and detatch the coating, filler, or ink from the paper fibers. They also aid in dispersing these particles and in some cases react with them to form soluable substances.

While alkalies perform the above tasks they do not have the ability to sufficiently emulsify these particles. In order to do this soap or a synthetic detergent is added to the deinking solution. These products tend to emulsify the ink and other particles and set up a repelling action between the fibers and these particles so that they may be more easily removed from the pulp by washing.[3]

Some wetting agents and detergents which can be

used to advantage in deinking are:[2]

1. Oleic acid
2. Gardinal
3. Duponol W.A. & E.S. pastes
4. Silicate of soda
5. DuPont M.P. 202 detergent & emulsifying agent
6. Tergitol

These are used in concentrations varying from .5 to 1%, based on the weight of the paper.

Following is a comparison of eleven deinking systems showing the amounts of sodium hydroxide and sodium carbonate. This comparison was made by Roderick O'donoghue.[3]

	1	2	3	4	5	6	7	8	9	10	11
% NaOH	---	4.5	---	---	.1	3.0	4.6	5.5	4.1	---	4.0
% Na_2CO_3	8.0	---	7.5	3.0	5.5	---	3.0	---	---	4.0	8.0
Cooking (hrs.)	1.5	.5	1.5	1.0	2.0	.25	.33	---	4.0	1.0	---

SODIUM CARBONATE V.S. CAUSTIC SODA

While a straight solution of sodium hydroxide will speed up the deinking operation its action is more detrimental to the fibers.[1] Experience has shown that there is a greater fiber loss when sodium hydroxide is used than when using sodium carbonate. However this is more than ofset by the time saved in treating the stock. Therefore some mills use a combination of both to get fairly rapid deinking with a minimum of fiber loss. There is no literature available on the use of

sodium phosphate.

DEINKING ACTION

Strachan gives the actual action of alkali solution on printed papers as follows:[7]

1. Neutralization of the alum in the paper, followed by rapid percolation of the cellulose by alkaline liquor.
2. Saponification of natural resins and sizing in and around the cellulose of the fibers, and to a limited extent of the dryed oily matter of the ink, followed by a loosening of adherant films of the latter.
3. Complete loosening of the dried ink by friction of the fibers against eachother.

   The use of soap results in a similar solution of resins and saponifiable matter and is most useful in the removal of inks containing resins and mineral oils, but the difficulty is to find a soap cheap enough for the purpose. As a rule the soap provided by the solution of resins is quite sufficient without further addition of fats.

Strachan also states that "printed papers carry on the average ½ to 1% by weight of printing ink."[7] The successful deinking of present day printed waste papers

lies in the necessity of a suitable chemical treatment carried out economically and with as little harm and loss to the fibers as possible. It is evident that time, labor, power, steam, and chemical cost are the important factors, the first probably being the most important as it affects all the others.

In order to reduce time, the ink must be quickly loosened and the fibers separated from eachother. Wetting agents will help in this action, also the addition of heat and a larger concentration of the alkali.[2] By agitating the stock at high consistency, the defibering action is speeded up, with the added advantage of lower total power, steam, and chemical costs. If the consistency is high the same amount of chemical will be in more concentrated form. However, the effect on the fiber is less drastic if the time element is reduced and the temperature kept low, as can be done by the use of wetting agents.[2]

Another advantage of quicker deinking of waste paper is that the stock is freer and more nearly of the character of the original fiber.[2] This fiber condition is of great importance in making some grades of paper. A long period of soaking and agitation required in some systems gives a slow weakened stock of mushy feel which is generally undesirable.

PRINTING INKS

In a study of deinking, consideration should be given to the composition of inks and how they are applied to the paper. Two general types are used: The first type of ink dries by quick absorbtion of the vehicle by the paper; the second type dries without depending on this.[5] The former has its principle application on newsprint and groundwood specialties, while the latter is used for less absorbant papers that are sized and coated.

Inks are made of a pigment and a vehicle, the pigment is the finely divided material that gives color and body to the ink, while the vehicle is the liquid in which it is suspended.

The pigment may be carbon as is commonly used in black inks or organic and inorganic colors used to make inks of various shades. Carbon is usually in the finely divided form known as carbon black. It is resistant to alkalies and soaps. Organic colors are usually derived from coal tar from which a large group of colors are obtained. When the color will dessolve in a solvent it is not a pigment but a dye.

Inorganic colors are colored substances of mineral origin. They are divided into two general classes namely natural colored earths and precipitated inorganic colors.[5] Most inorganic pigments used in printing inks

are precipitated pigments.

The composition of the vehicle depends upon the use to which the ink is applied and may be composed of one or more of the following: Heat processed vegetable oils, such as linseed, perilla, tung, dehydrated castor oil etc; menhaden fish oil, oil alone or heat processed in combination with vegetable oils; vegetable oils in combination with resins, driers, with or without volatile thinner and waxes, petroleum or mineral oils of high and low boiling points, with or without resins; resin with plasticizer and a volatile thinner; cellulose esters, plasticizer and low or high boiling solvent; casein water emulsion.[5] In general the vehicle is made up of combinations of oils, resins, driers, thinners, and special compounds.

The types of drying required in an ink greatly influence the choice of resins used. The types of drying are oxidation, polymerization, condensation, penetration, and absorbtion, aniline inks by evaporation and tinplate inks dry by means of heat, where the drying is done mainly by polymerization, condensation and some oxidation.[5]

Driers usually consist of a metallic salt such as derived from lead, manganese and cobalt are used to speed drying of the ink. Thinners are employed to control the consistency of the ink. Special compounds are used to

quickly set the ink, decrease tack, eliminate "picking of the paper", and prevent offset. These are commonly lanolin, lard, soaps, tallow, waxes and combinations with various oils, asphaltum and resins.[5]

NEW PROBLEMS IN DEINKING

The introduction of paper highly loaded with calcium carbonate filler has made deinking more difficult. This is because of the affinity of the filler for ink and the resultant production of insoluable compounds.

Also insoluable compounds are formed when casein coated papers are used in the deinking process.[2]

The developement of machine coated papers has introduced a number of problems. A large part of the machine coated papers contain ground-wood.

In the past most papers were printed with oil base inks which consisted of finely divided carbon and mineral colors in an oil vehicle. This vehicle might be oxidized, boiled linseed oil, soya bean oil etc.

The high speed presses of today require quick drying inks. On fine paper the surface must be smooth and hard for good printing, ink is absorbed more slowly. To avoid smudging this latter type of paper, the Heat-set inks have been developed.[2] These inks consist of a large percentage of volatile material with a resin base. In printing, the paper is heated to a high temperature,

which drives off the volatile materials and bakes what remains into a hard film.

Another recent developement is in the use of Gold-set inks which are applied hot to heated rolls and plates.[2] When applied to the comparitively cold sheet they set quickly.

Another recent inovation is that of spraying the printed sheet with flour and water, stc. to prevent offset. In addition there are papers which are laquered or varnished to give a high gloss.

Printed wax papers cannot be used unless they are dewaxed.

It can be seen from the above that modern printing technique and consequent paper characteristics present problems which are new.

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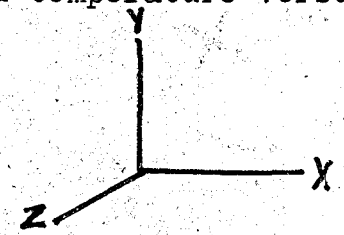
OUTLINE OF EXPERIMENTAL WORK

The purpose of these experiments will be to determine the effect of various mill deinking procedures upon the strength of chemical wood fibers; Therefore the basis for these experiments is the desire to approximate, as closely as possible mill production conditions with the equipment and time available.

As a preliminary experiment it was decided to find the exact concentration of alkali required to obtain complete deinking at various temperatures. This is important since it is senseless to try to deink with too low a concentration of alkali. With too low a concentration complete deinking cannot be accomplished within a specified length of time. Also the same applies with using concentrations of alkali in excess to the required amount. To do this experiment a series of square pieces of white cloth will be printed with bold face type on a proof press. These pieces of cloth will then be deinked in various concentrations of sodium hydroxide, sodium carbonate, and mixtures of both at various temperatures to determine the time required for deinking. Wetting agents will be added to some of the above solutions to determine the effect they have on the deinking variables. When deinking is completed will be determined by visual inspection.

After completion of this preliminary experiment the results will be plotted in three dimension. This will be done be plotting temperature versus concentration and temperature versus the time required for deinking.



The X axis is concentration.

The Y axis is Temperature.

The Z axis is Time required.

To determine the effect of various mill deinking procedures upon the strength of chemical wood fibers, points on the above curve will be chosen and actual deinking carried out at the temperature, concentration, and time values corresponding to that point. After deinking a beater run will be made on the pulp and the handsheets made will be tested for tear and mullen. The tear versus the mullen will then be plotted on graph paper. The relative strength of the pulp will be determined by the distance of the curve from the origin.

Cooking

In order to duplicate mill conditions as closely as possible an approximation of a centrifugal pulper is to be used. This apparatus consists of a drill press, a 3 15/16" diameter agitator, and a twenty liter stainless steel pail.

The constants in cooking will be:

Amount of stock used - 600 grams

Kind of stock used - Virgin Weyerhaeuser Bleached Sulphite.

Consistency - 5%

Pressure - Atmospheric pressure

The pulp must be weighed accurately since we are interested in yield.

Variables in cooking will be:

Temperature - 130-180 degrees Fahrenheit

Concentration of chemical - 1-5%

Time of cook - 30-90 minutes

Disintegration

There is no need to disintegrate the stock since this will be accomplished in cooking.

Washing

The stock will be washed in a Buchner funnel. This is important since it is desirous to prevent the loss of any fiber.

Determination of the Relative Pulp Strength

The pulp will be beaten in a Valley beater. Handsheets will be made at various time intervals, on the Noble and Wood sheet mold. The sheets will then be pressed in the Noble and Wood press and dried on the Noble and Wood drier.

After allowing the sheets to come to standard conditions in the humidity room, they will be tested for mullen and tear.

The deinked pulp will also be tested for alpha-cellulose content and copper number to find the relative amount of degradation.

Results Expected

An increase in the concentration of the alkali will reduce the time required for deinking with a corresponding decrease in the strength of the pulp.

An increase in the temperature will also reduce the time required for deinking and decrease the strength of the deinked pulp.

An increase in the time required for deinking will be accompanied by a decrease in the strength lost by the pulp.

EXPERIMENTAL DATA

Preliminary Experiments

The purpose of these experiments was to try to establish the minimum cooking conditions under which complete solution of the ink binder could be obtained. To do this it was decided to take squares of white cloth and print them on a Vandercook proof press. Cloths were used since they would not disintegrate in the deinking procedure and therefore would permit establishment of minimum cooking conditions by visual inspection. The end-point being the point below which there was a sharp increase in the amount of ink remaining on the cloth. The ink used in these experiments was Everyday Bond Black a product of International Printing Inks Co. Excess ink was placed on the metal ink roller in hopes that the rubber pick up rolls would hold a constant amount of ink. After printing the cloths were set aside to permit the ink to dry.

The attempt to deink these cloths were carried out one-liter stainless steel jars. The chemical concentrations used were 2.5% Sodium hydroxide and 5% Sodium hydroxide. The temperatures used were 150 degrees F., 180 degrees F., and 212 degrees Fahrenheit. Samples of cloth were removed from the deinking solutions every one-half hour up to three hours cooking time. Seeing that no visual end-point was to be reached with the above chemical concentrations,

it was decided to try 20% Sodium hydroxide at 212 degrees Fahrenheit. This was done to see if it was possible to attain an end-point. The results of this experiment are shown in Figure I. As can be seen no end-point was reached. To try to get around this problem the above tests were re-run under the same conditions and the liquor from the deinked samples was filtered through a Buchner funnel. Brightnesses were then run on the filter papers by the use of a Photo Volt brightness tester. It was soon found that the brightnesses obtained were not in correlation with the amount of ink removed, but rather with the ink distribution. The ink tended to gather at the holes in the Buchner funnel and therefore did not give an even distribution of the ink particles. The results of one such test are given in Table I.

In an alternative procedure, magazines were used in place of the squares of cloth. The magazines used were Life, Colliers, and the Saturday Evening Post. The magazines were slushed at 4% consistency in an approximation of a centrifugal pulper. This apparatus consisted of a drill press, a 3 15/16" agitator, and a 12-liter stainless steel pail. The slushed magazine stock was then deinked at 4% consistency in the same manner as the cloths. It was found that the brightness difference

between the original slushed stock and the final deinked stock was never greater than four points. This difference was thought relatively inadequate for determination of accurate end-points.

Experiments on Virgin Pulp

The purpose of these experiments was to determine the effect of various deinking solutions and concentrations upon the strength of fiber.

Cooking

In the outline of experimental work it was decided that the variables in cooking would be the temperature, chemicals used, and the concentration of chemical used. Time of cooking, consistency, apparatus, washing method, and weight of pulp used remaining constant.

The apparatus used in cooking was the approximation to the centrifugal pulper previously described.

The constants in cooking were:

Time of cook	60 minutes
Consistency	4%
Amount of stock used	380 grams
Kind of stock used	100% bl. sulphite

Since we are not interested in brightness the stock used was a standard virgin pulp. This was done to permit greater reproducability of results.

FIGURE Ia

A sample of the printed cloth used in search for minimum cooking condi

NON-RESIDENT STUDENTS

Tuition	Local Fees	Total
$84.00	$32.50	$116.50
56.00	27.50	83.50
42.00	25.00	67.00
28.00	22.50	50.50
14.00	20.00	34.00

3 - 4 semester hours

Tuition	Local Fees	Total
$42.00	$32.50	$74.50
28.00	27.50	55.50
21.00	25.00	46.00
14.00	22.50	36.50

2 semester hours

RESIDENT STUDENTS

Tuition	Local Fees	Total
$14.00	$20.00	$34.00
28.00	20.00	48.00
42.00	20.00	62.00

NON-RESIDENT STUDENTS

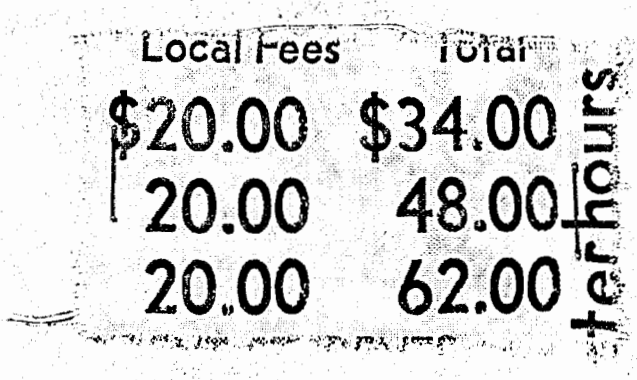
Tuition	Local Fees	Total
$7.00	$20.00	$27.00
14.00	20.00	34.00
21.00	20.00	41.00

6 - 9 semester hours

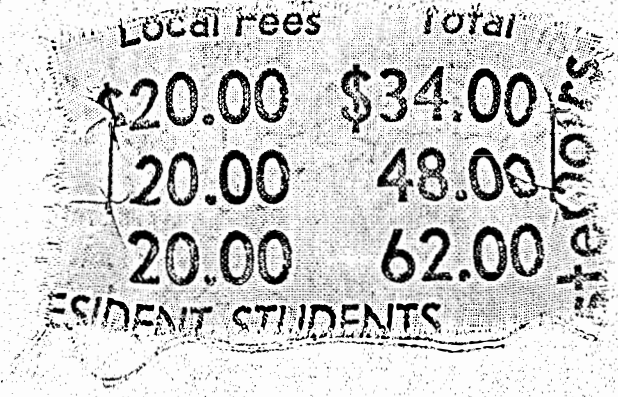
FIGURE Ib

Deinking at 212 degrees F. with 20% Sodium hydroxide.

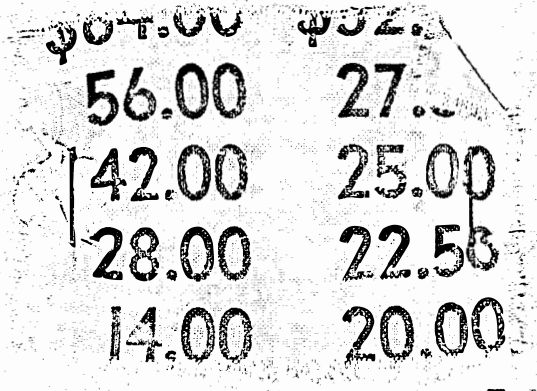
One-half hour



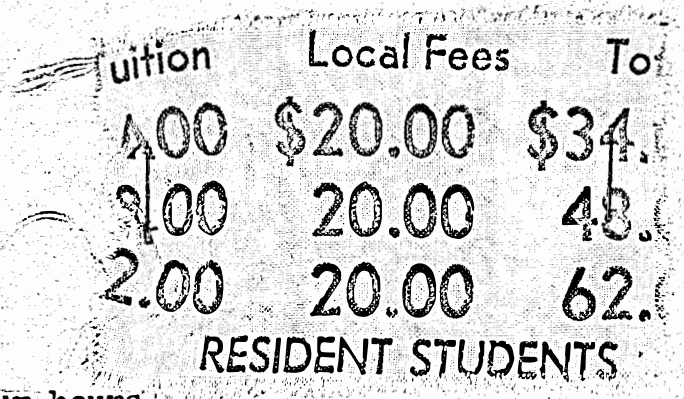
One hour



One and one-half hours



Two hours



Four hours

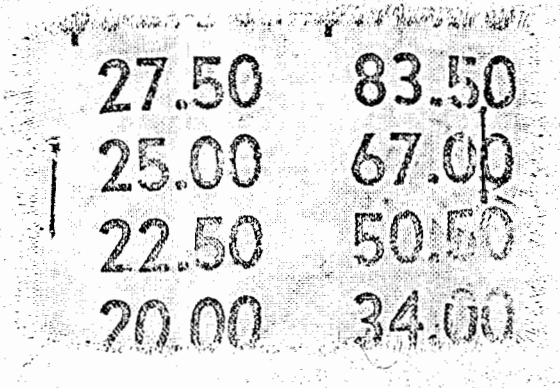


TABLE I

150 degrees F.		180 degrees F.		212 degrees F.	
Time	Bright.	Time	Bright.	Time	Bright.
1 hour	79.0%	1 hour	75.5%	1 hour	78.5%
1½ hours	82.5%	1½ hours	81.5%	1½ hours	80.0%
2 hours	81.5%	2 hours	78.0%	2 hours	77.5%
2½ hours	82.0%	2½ hours	79.5%	2½ hours	79.5%
3 hours	81.0%	3 hours	71.0%	3 hours	79.0%
3½ hours	-----	3½ hours	-----	3½ hours	74.5%

The variables in cooking were:

Temperature	180 degrees F. 212 degrees F.
Chemicals used	Sodium hydroxide Sodium carbonate
Chemical concentrations (% on air dry pulp)	2.5% 5%

Eight deinkings were made, they were:

1) A blank
2) 2.5% Sodium hydroxide at 180 degrees F.
3) 5% Sodium hydroxide at 180 degrees F.
4) 2.5% Sodium hydroxide plus 2.5% Sodium carbonate at 180 degrees F.
5) 5% Sodium hydroxide at 212 degrees F.
6) 2.5% Sodium carbonate at 180 degrees F.
7) 5% Sodium carbonate at 180 degrees F.
8) 5% Sodium Carbonate at 212 degrees F.

Washing

After deinking the stock was washed in a 18" by 36" tank washer with a 150 mesh screen in the bottom. The water was added by the use of a hose. The stock was washed for a period of three minutes. After washing the stock was allowed to drain and then removed ready for use in the beater.

Beating

Beater runs were then made on the washed stock in a Valley laboratory beater. Handsheets were made at various time intervals (the exact intervals are not important) on the Noble and Wood sheet mold. All sheets were made in accordance with TAPPI Standards specifications. The sheets were then pressed in the Noble and Wood press and dried in the Noble and Wood drier.

Testing

The sheets were conditioned in the humidity room for at least two days before testing. After conditioning the sheets were tested for basis weight, Mullen, and Tear. The tear tests were run on the Elmendorf Tear Tester and the mullen tests were run on the Perkins Constant Load Mullen Tester. The results of these tests are shown in Table II, and comparisons are shown in Figures II, III, IV, V, VI.

TABLE II

The following are results obtained from the strength evaluation of the deinked stock. All values have been corrected to the TAPPI standard sheet weight of 2.48 grams.

Number I-a blank

Minutes beating	0	5	10	17	24	29	34
Mullen	2.65	8.9	15.6	18.7	22.0	21.9	24.1
Tear	32.4	62.0	41.0	35.6	30.8	27.3	23.5

Number II-2.5% Sodium hydroxide at 180 degrees F.

Minutes beating	0	5	10	15	22	27	34
Mullen	6.3	12.0	17.0	18.2	19.6	20.0	20.0
Tear	63.0	49.2	32.0	27.8	24.7	22.0	19.3

Number III-5% Sodium hydroxide at 180 degrees F.

Minutes beating	0	5	10	17	23
Mullen	7.4	13.4	18.8	20.4	20.4
Tear	61.0	48.0	35.0	29.0	25.3

Number IV-2.5% NaOH plus 2.5% Na_2CO_3 at 180 degrees F.

Minutes Beating	0	5	10	17	23	29
Mullen	8.4	16.3	19.5	21.4	22.0	21.8
Tear	60.5	41.3	32.4	26.4	23.7	21.4

TABLE II continued

Number V-5% Sodium hydroxide at 212 degrees F.

Minutes Beating	0	5	10	17	23	29
Mullen	8.03	15.4	17.4	18.6	19.0	17.5
Tear	65.0	45.5	35.1	30.6	25.8	22.5

Number VI-2.5% Sodium carbonate at 180 degrees F.

Minutes beating	0	5	10	17	23	29
Mullen	7.5	14.2	17.6	19.5	20.7	20.6
Tear	49.2	45.5	34.6	27.9	21.4	21.0

Number VII-5% Sodium carbonate at 180 degrees F.

Minutes beating	0	5	10	17	23	29
Mullen	7.5	14.25	17.7	19.6	20.0	19.95
Tear	58.3	43.2	32.8	26.6	23.4	19.95

Number VIII-5% Sodium carbonate at 212 degrees F.

Minutes Beating	0	5	10	17	23	29
Mullen	7.75	13.95	18.4	19.75	21.0	21.4
Tear	57.0	47.6	35.7	28.7	23.2	21.2

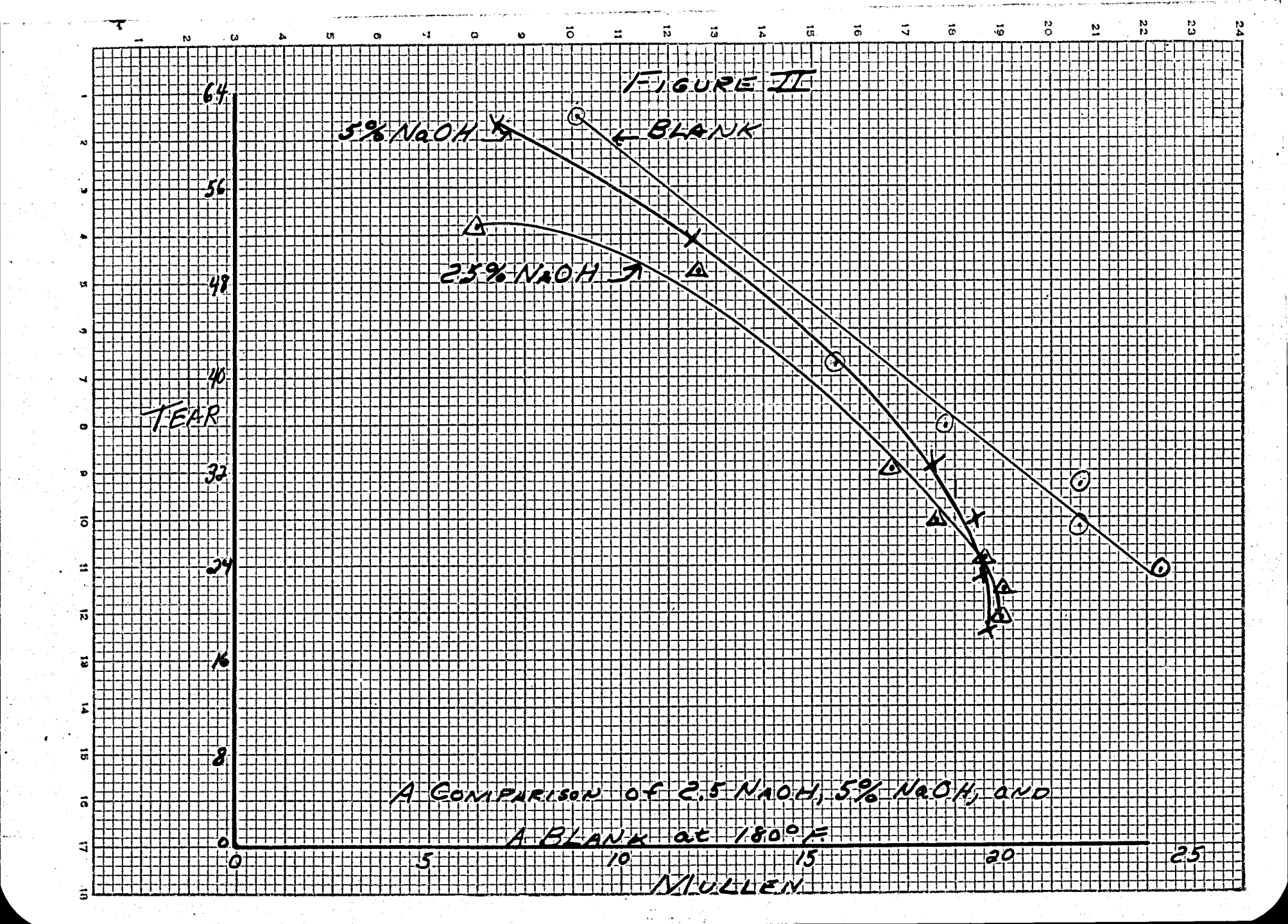


FIGURE II
5% NaOH
BLANK
2.5% NaOH
64
56
48
40
32
24
16
8
0
TEAR
0
5
10
15
20
25
MULLEN
A COMPARISON OF 2.5 NaOH, 5% NaOH, AND A BLANK at 180° F.

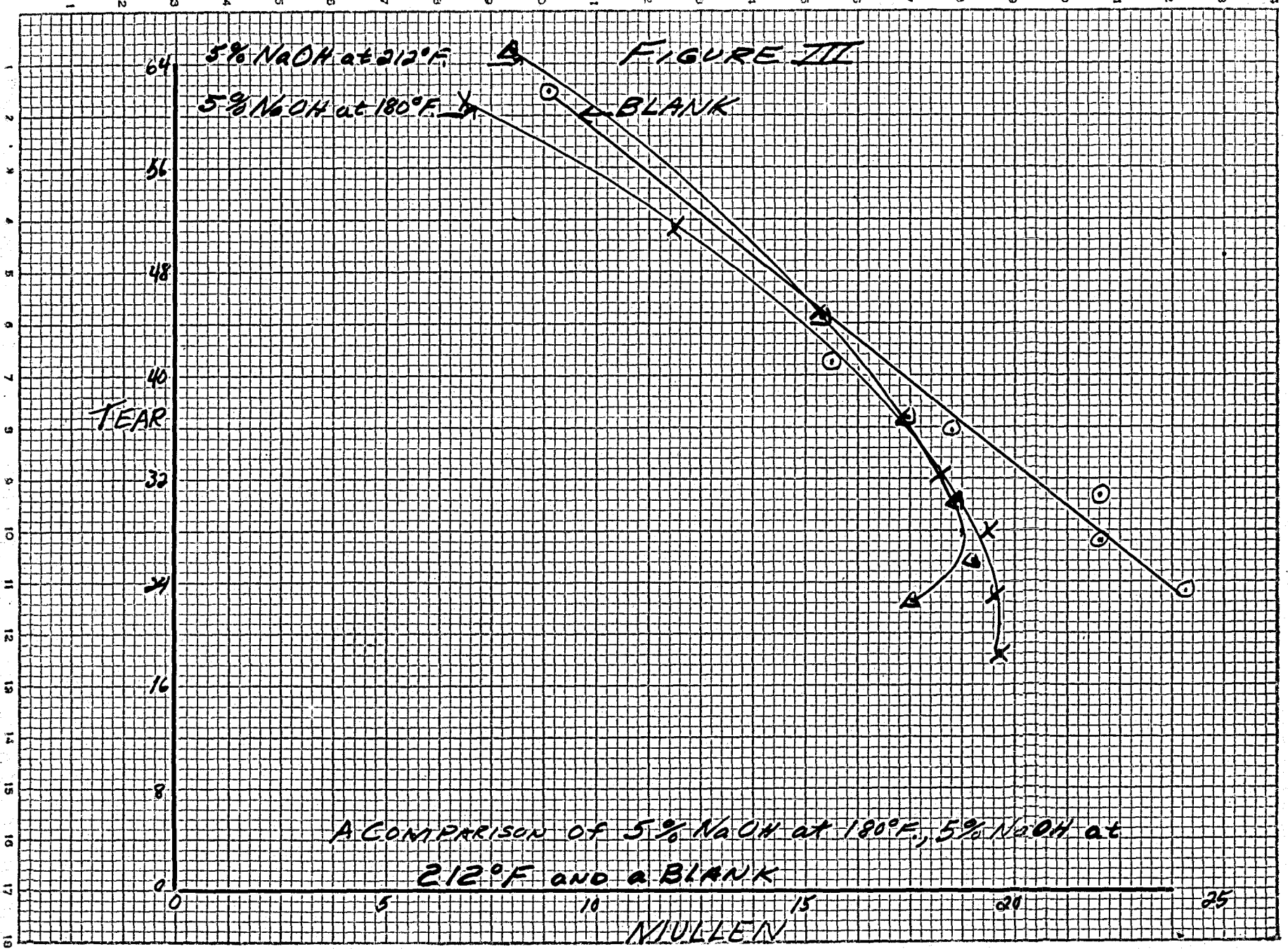


FIGURE III
5% NaOH at 212°F.
5% NaOH at 180°F.
BLANK
64
56
48
40
32
24
16
8
0
TEAR
0
5
10
15
20
25
MULLEN
A COMPARISON OF 5% NaOH at 180°F., 5% NaOH at 212°F AND a BLANK

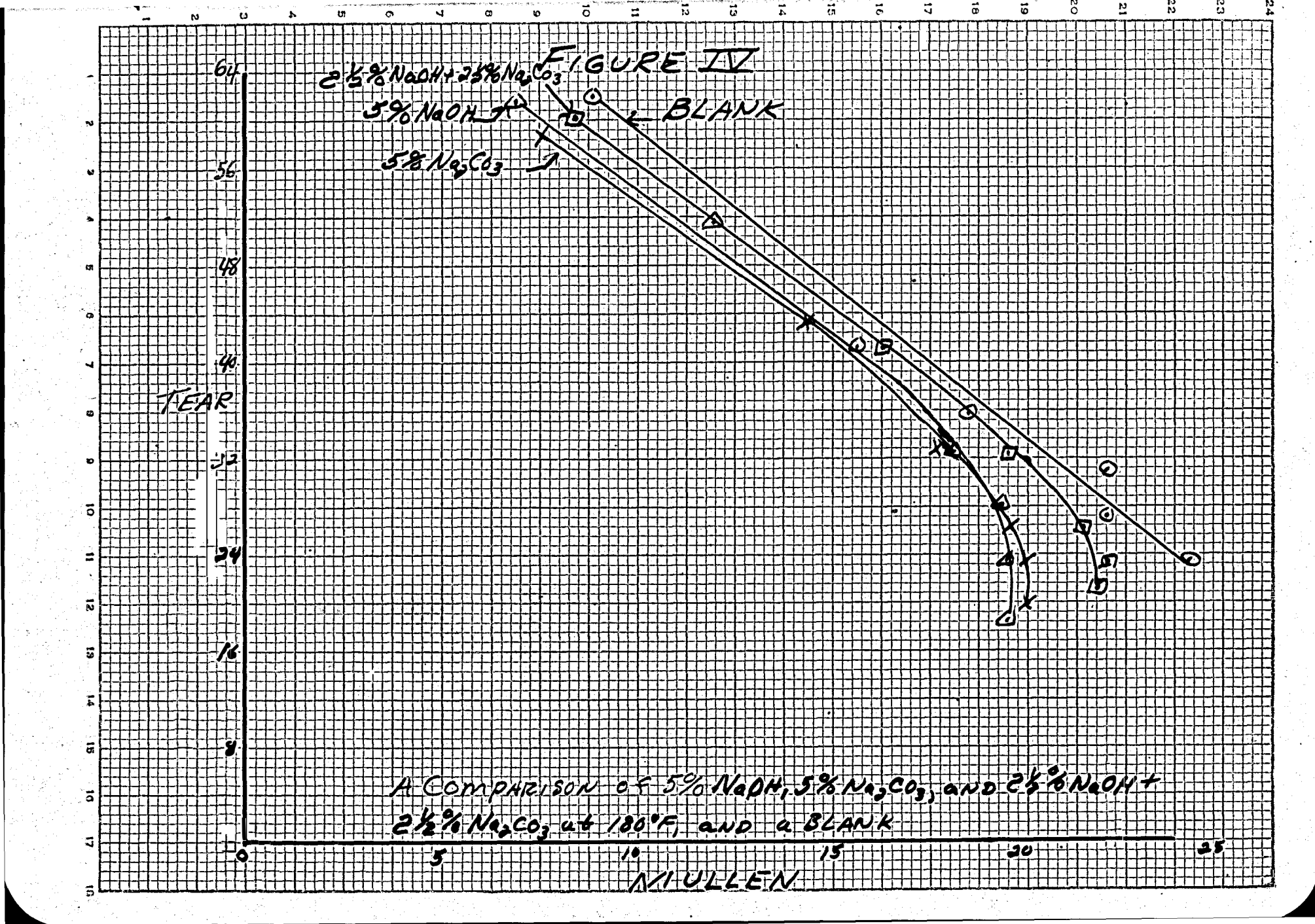


FIGURE IV
2½% NaOH + 2½% Na2CO3
5% NaOH
5% Na2CO3
BLANK
64
56
48
40
32
24
16
8
0
TEAR
5
10
15
20
25
MULLEN
A COMPARISON OF 5% NaOH, 5% Na2CO3, AND 2½% NaOH + 2½% Na2CO3 at 180°F, AND a BLANK

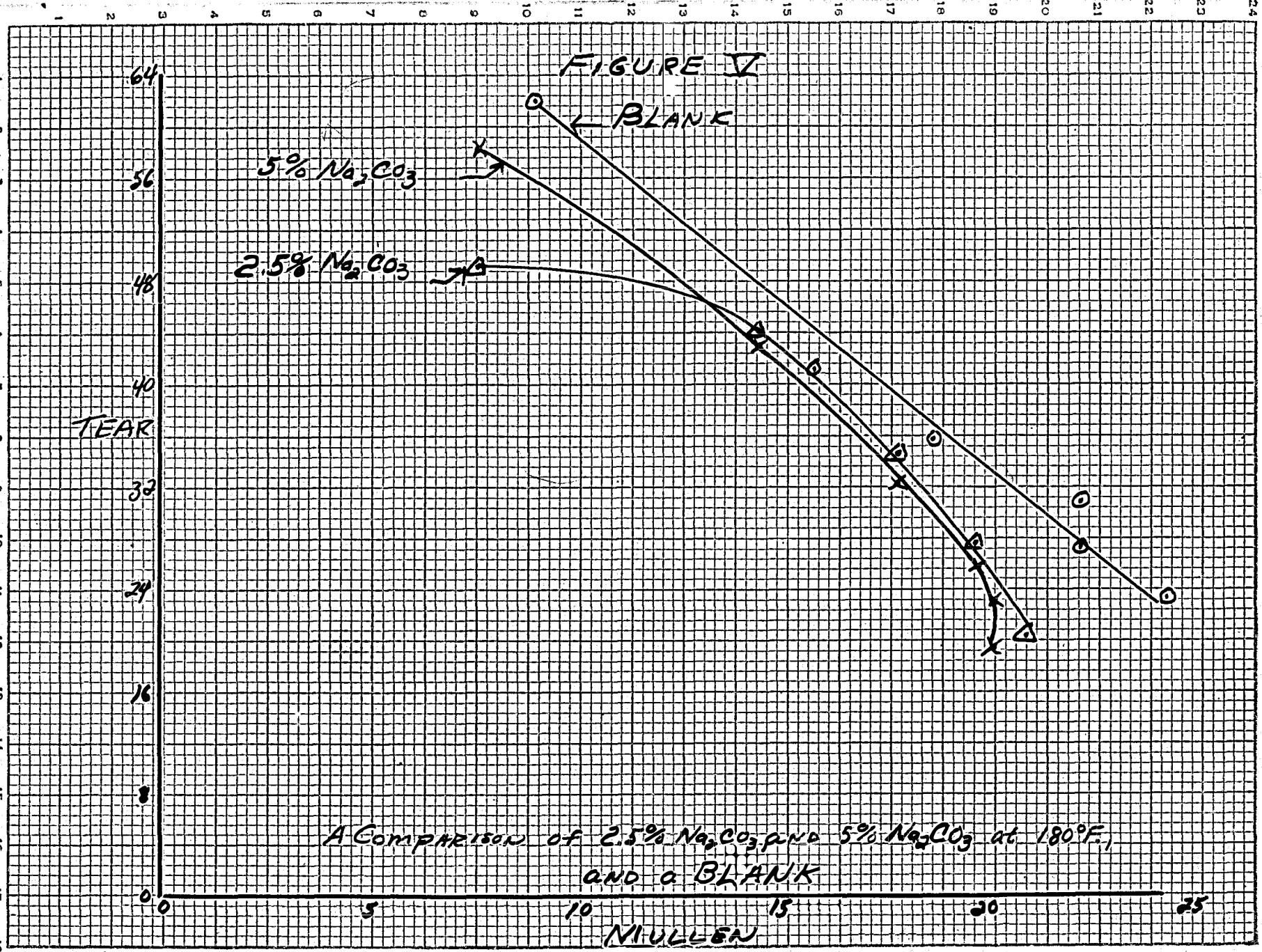


FIGURE V
BLANK
5% Na_2CO_3
2.5% Na_2CO_3
64
56
48
40
32
24
16
8
0
TEAR
0
5
10
15
20
25
MULLEN
A COMPARISON of 2.5% Na_2CO_3 and 5% Na_2CO_3 at 180°F.
AND a BLANK

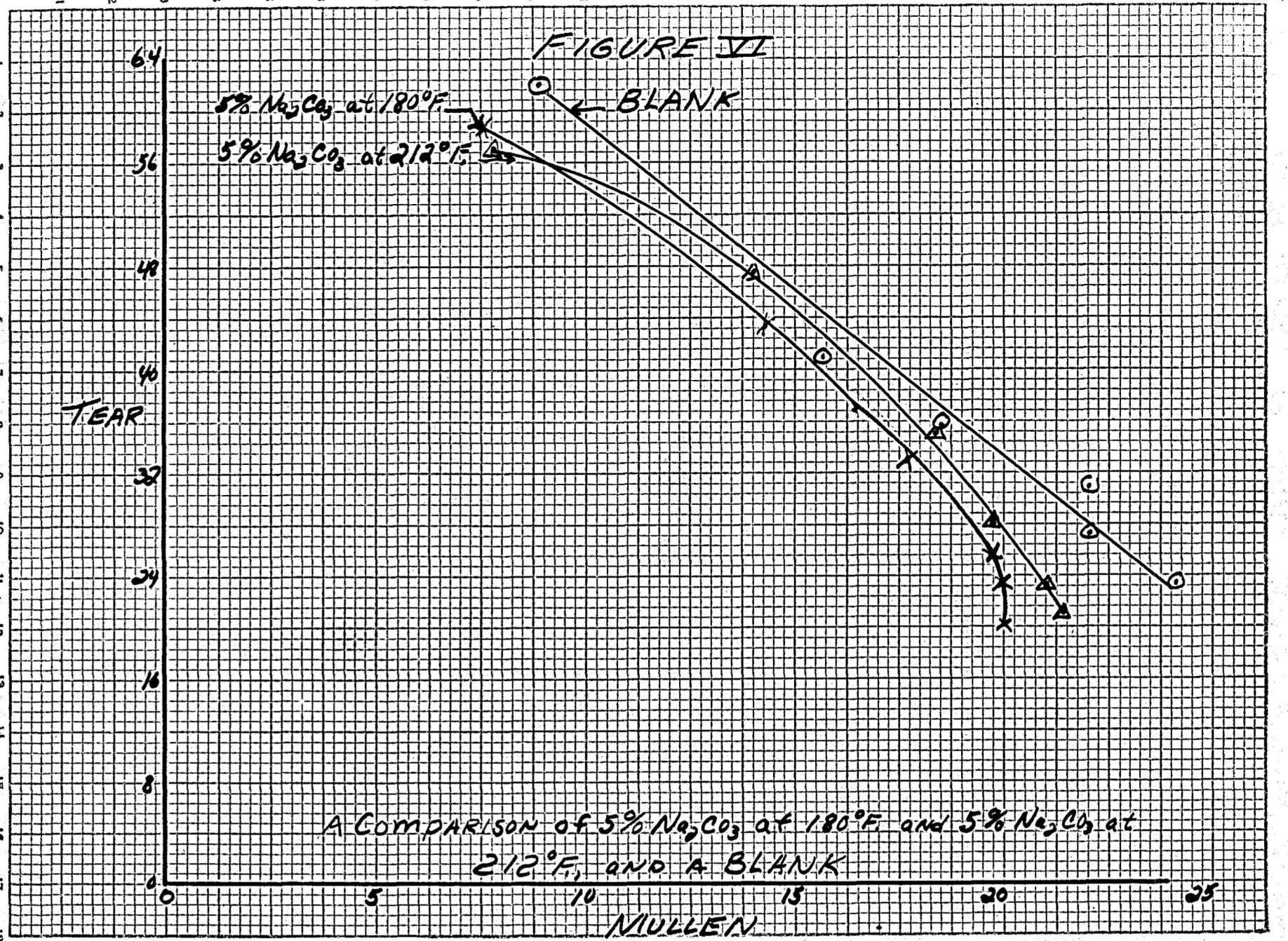


FIGURE VI
BLANK
5% Na_2CO_3 at 180°F.
5% Na_2CO_3 at 212°F.
TEAR
64
56
48
40
32
24
16
8
0
0
5
10
15
20
25
MULLEN
A COMPARISON OF 5% Na_2CO_3 at 180°F. and 5% Na_2CO_3 at 212°F, AND A BLANK

SUMMARY

It is generally accepted that deinking has an effect upon the strength of fiber. The exact nature of this effect is not known, but it is known that any chemical treatment can be suspected of weakening the fibers. The purpose of this experiments was to try to determine what the effect is.

Ink, of course, is a combination of a pigment plus a binder to hold the ink to the paper. Instead of jumping right into the problem it was decided to run preliminary tests to try to establish the minimum cooking conditions under which complete solution of the ink binder could be obtained. This would have been desirable since excess chemical, time, or too high temperatures would be expected to have more of a destructive effect upon the strength of fiber. This also would permit the comparison of the effects of these various chemicals, concentrations, and temperatures on a minimum basis. To do this it was decided to take squares of white cloth and print them with Everyday Bond Black. These cloths were then deinked in hopes that a sharp end-point would be reached. This end-point being determined by visual inspection. Unfortunately no end-point was reached, and no minimum conditions were found, below which there was

a sharp increase in the ink remaining on the cloth. All the ink was not removed, in fact some of the ink remained after the cloth had been almost disintegrated by the caustic. The reason for this was that cooking alone with a deinking agent is inadequate. It must be accompanied by inter-fiber friction.

An attempt was made to measure the degree of ink removal from the cloth by filtering the liquor after deinking and measuring the brightness of the filter paper. Brightness would be expected to indicate the amount of ink pigment removed, but here too, no sharp end-point could be found to indicate what minimum cooking conditions are necessary to loosen ink.

As an alternative procedure magazines were used in place of the squares of cloth. The brightnesses obtained were not sufficiently different from the brightness of the original slushed stock to be of value in determining the minimum cooking conditions desired. This also bears out our previous statement on the importance of inter-fiber friction.

Subsequent tests have been limited to commercial cooking conditions without inquiring as to whether these actually are minimum conditions for accomplishing the desired results. In other words, the obtained data reflect commercial results without stating whether

commercial cooking is actually overcooking. The chemicals used in these experiments were Sodium hydroxide, Sodium carbonate, and a mixture of the two. The pulp used in these experiments was 100% bleached sulphite.

After deinking the stock was washed and then beater runs were made on the pulp. The prepared handsheets were tested for basis weight, mullen, and tear. Of course you can attain a high tear with any pulp and with beating you can attain a high mullen with any pulp. The strength was determined by the method outlined in the experimental outline. The physical strength results of the handsheets are shown in Table II. As can be seen from Table II and FiguresII, III, IV, V,and VI, after the initial decrease in strength any increase in chemical concentration or temperature increases the initial strength of the pulp due to an increase in solvation of the Hemicellulose fraction. With added beating the effect of deinking overcomes the initial increase in strength and the strength decreases at a rate in correlation with the amount of chemical or temperature used. In the comparison of 5% Sodium hydroxide, 5% Sodium carbonate, and 2.5% of each, we see that a mixture of the two has less destructive effect upon the fiber than the previous two.

CONCLUSIONS

These experiments have shown that deinking does have a destructive effect upon the strength of fibers. This effect is in correlation to the temperature and amount of chemical used. Also shown is the fact that a mixture of Sodium hydroxide and Sodium carbonate has less of a destructive effect upon the fibers than either of these chemicals alone.