Beating Characteristics of Bamboo Pulp in Banning Beaters : Effect of Consistency on Power Consumption and Pulp Sheet Properties

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Bleached bamboo pulp of Central Pulp Mills was beaten in two pilot plant Banning beaters, one having phosphorbronze tackle and the other having basalt lava stone roll and bed plate. The consistency of the stock during beating was kept at 4%, 6% and 8%

The results indicate that at higher consistencies, less power is consumed. Stone roll beater consumes less energy for the same degree of beating. Breaking length and burst factor are higher when the pulp is beaten with phosphorbronze tackle and the difference is more pronounced at lower consistency, whereas stone roll beater gives a higher tear factor and the difference is more pronounced at higher consistency.

Introduction

It is well said that the paper is made in the beater. If this is elaborated a little further it actualiy means that the physical characteristic of the fibres is changed during the course of beating to meet the paper maker's demand. The main factor governing the economics of beating is the power required to do the work on the fibre to impart the required physical characteristics. This power requirement is not only dependent on the nature of the pulp but is also dependent on the material of construction and design of the beater as well as on the consistency of the stock in the beater. With a view to study these factors, the present study was undertaken and the results are presented here.

Experimental

Bleached bamboo pulp of Central pulp mills was beaten in two pilot plant Banning beaters, onehaving phosphorbronze tackle and the other having basalt lava stone roll and bed plate. In every set of experiments about 400 Kg. of bamboo pulp was soaked in water overnight in the beater to open out the pulp. The consistency of the stock was adjusted at 4%, 6% and 8% by the addition of the required amount of water. Power consumption during the course of beating was recorded at different time intervals and the samples of the pulp were also taken out at these time intervals. Freeness of these samples was determined. Standard sheets of 60 g.s.m. were prepared and tested for various physical properties after conditioning at 65% R.H. and 25°C.

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Result and discussions

Result of these experiments are shown graphically in Fig. 1 to 4.

Power consumptions freeness

In Fig. 1, power consumption at various consistencies in Banning beaters is plotted against freeness. It can be seen that the relationship is linear as expected. The Fig. indicates that at higher consistencies, less power is consumed.

For comparison of the efficiency of the two beaters, power consumption was interpolated from Fig. 1 at 250 ml. (C.S F.) has been recorded in Table I. It will be seen from the table that stone roll beater consumes less energy for the same degree of beating. This is due to the

difference in the design of these tackles.

2. Physical strength properties Vs. freeness:

Physical strength properties of the pulps beaten in two banning beaters at various consistencies are plotted against freeness in Fig. 2. It is seen from this figure that breaking length and burst factor are higher when the pulp is beaten with phosphor-bronze takcls and the difference in these properties is more pronounced at lower consistency. Stone roll beater gives higher tear factor and the difference is more pronounced at higher consistency.

Physical strength properties at 250 ml. (C.S.F.) freeness were interpolated from Fig. 2 for comparison of these two beaters. These are recorded in Table–II. The data in this table supports the above stated findings. The reason for this difference in strength properties may be due to the difference in the construction of roll and bed plate of these two beaters. Their action on the fibres is apparently different. Phosphorbronze tackle is sharp while that of basalt lava stone is blunt. Beating with phosphorbronze tackle probably results in more action of the fibres at low consistency. This difference results in poor tear and high breaking length and burst factor in case of phosphorbronze takcle.

At higher consistencies there is apparently more rubbing action

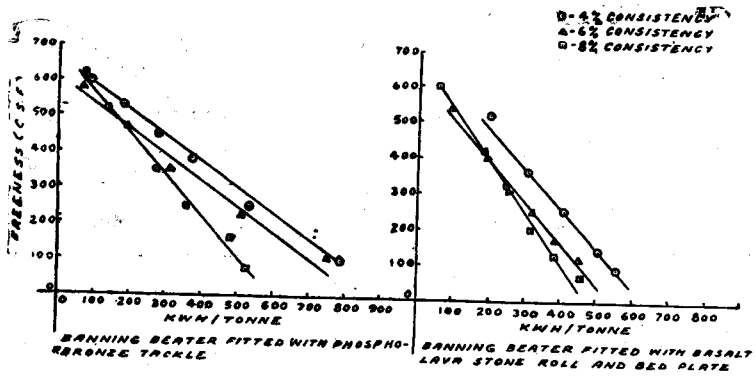

FIG. 1. RELATIONSHIP BETWEEN FREENESS AND POWER CONSUMPTION AT VARIOUS CONSISTENCIES IN BANNING BEATERS.

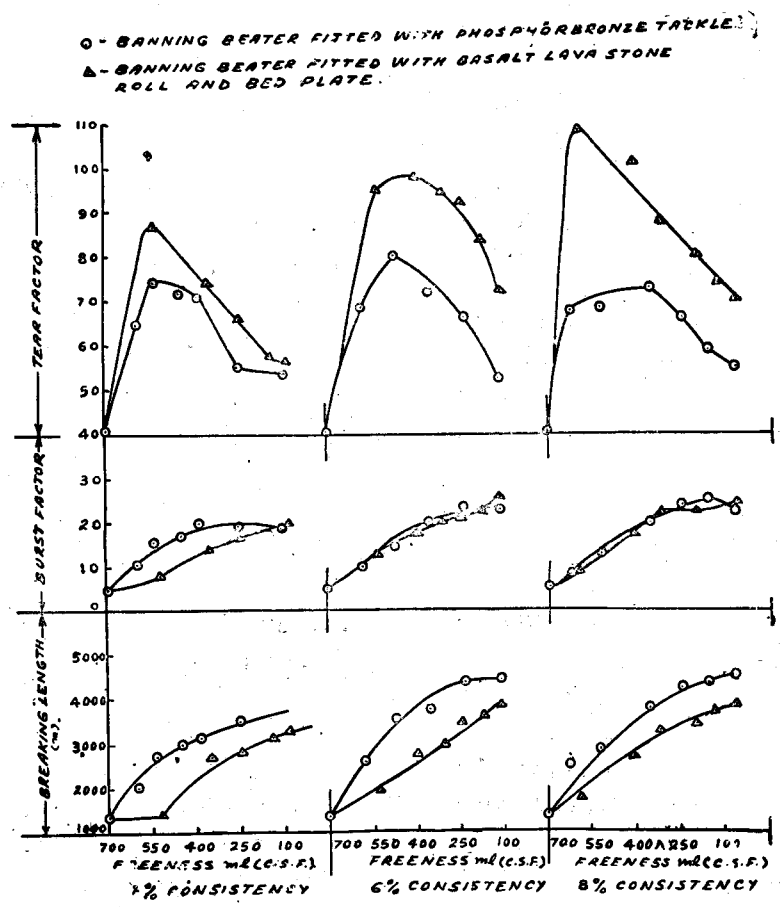

FIG. 2. BEATING CHARACTERISTICS OF BAMBOO PULP AT DIFFERENT CONSISTENCIES IN BANNING BEATERS.

Table–I Power consumption KWH/tonne at 250 ml. (C.S.F.) freeness at various consistencies using Banning beaters

Type of Banning beater	CONSISTENCY		
	4%	6%	8%
1	2	3	4
Phosphorbroneze tackle	570	500	375
stone roll	405	320	300

Table–II Physical strength properties at 250 ml. (C.S.F.) freeness at various consistencies using Banning beaters.

Type of Banning beater	4% consistency			6% consistency			8% consistency		
	Breaking length metres	Burst factor —	Tear factor —	Breaking length metres	Burst factor —	Tear factor —	Breaking length metres	Burst factor —	Tear factor
1.	2	3	4	5	6	7	8	9	10
Phosphorbroaze tackle	3500	20.0	55.0	4340	22.5	68.0	4200	23.4	66.0
Stone roll	2900	16.4	66.0	3200	21.0	90.0	3440	22.2	83.5

between the fibres resulting in more exposed surface area and better swelling. This results in better fibre to fibre bonding yielding higher strength.

3. Inter relationship betweeu fibre bonding strength, sheet property Vs. degree of beating

Breaking length is a direct measure of fibre bonding strength in a sheet while bulk reflects the compactness of the sheet. With beating normally breaking length incresses while bulk decreases. The effect of variation in the compactness of the sheet on breaking length can be nullified by dividing breaking length by bulk. The breaking length bulk will thus give a qualitative indication of bonding strength. An attempt was made to correlate this bonding strength with the degree of beating by plotting breaking length/bulk against freeness (Fig. 3). The relationship is linear. It is also independent of consistency and the design of the beater, as all the lines are more or less parallel. Further work on this relationship is in progress.

4. Power consumption Vs. pulp sheet properties

The graphs Fig. 4 ard Fig. 5 were plotted between breaking length against power consumption and bulk against power consumption respectively for evaluating

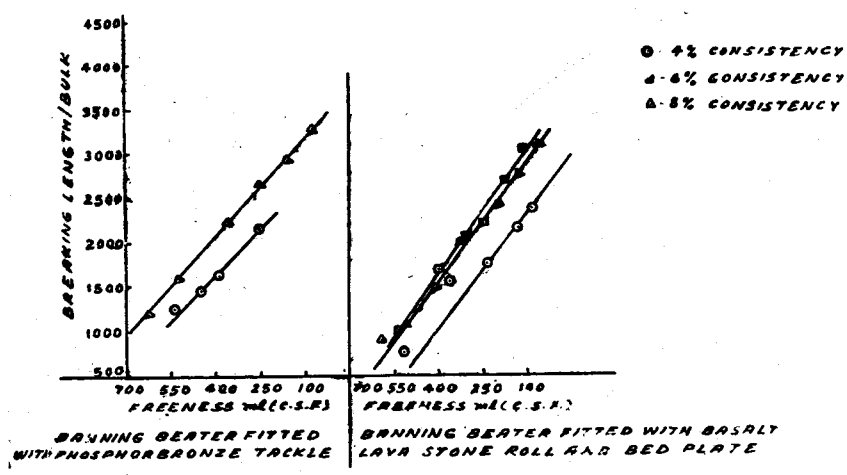

FIG. 3. RELATIONSHIP BETWEEN FREENESS AND SHEET PROPERTY OF BAMBOO PULP BEATEN AT VARIOUS CONSISTENCIES IN BANNING BEATERS.

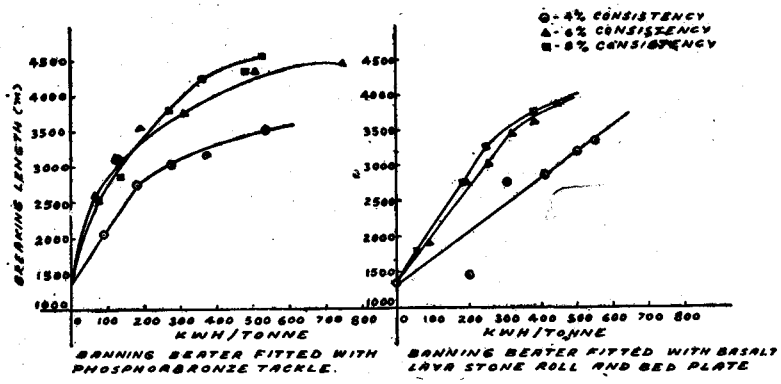

FIG. 4. RELATIONSHIP BETWEEN BREAKING LENGTH AND ENERGY CONSUMPTION AT VARIOUS CONSISTENCIES IN BANNING BEATERS.

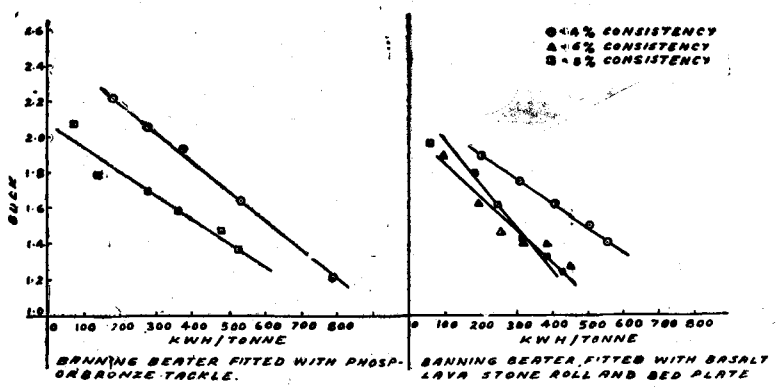

FIG. 5 RELATIONSHIP BETWEEN BULK AND POWER CONSUMPTION AT VARIOUS CONSISTENCIES IN BANNING BEATERS.

the effect of energy input on pulp sheet properties. The results were interpolated at 400 KWH/tonne as with this energy consumption the phosphorbronze tackle gave a pulp of about 250ml. (C.S F.) freeness. The results are recorded in Table III. Freeness values at 400 KWH/tonne were found out from Fig. 1 are also recorded in Table III.

It is seen from this table that pulps when beaten in phosphorbronze tackle gave breaking length. bulk and freeness higher than the pulps beaten with stone roll, irrespective of consistency, at the same power consumption.

Conculsions

1. At higher consistencies (upto 8%) less power is consumed for the same degree of beating.
2. Stone roll beater consumes less energy for the same degree of beating.

Table III Physical strength properties produced by consuming 400 KWH/tonne power at various consistencies using Banning beaters

Type of Banning beater	CONSISTENCY		
	4%	6%	8%
1	2	3	4
Breaking length, metres			
1. Phosphorbronze tackle	3320	4000	4350
2. Stone roll	2800	3700	3800
Bulk, cc/g			
1. Phosphorbronze tackle	1.86	—	1.54
2. Stone roll	1.62	1.28	1.24
Freeness, ml. (C.S.F.)			
1. Phosphorbronze tackle	370	320	220
2. Stone roll	255	155	100

3. Breaking length and burst factor are higher when the pulp is beaten with phosphor-bronze tackle and the difference is more pronounced at lower concistency, whereas stone roll beater gives a higher tear factor and the difference is more pronounced at higher consistency,

4. The relationship between breaking length/bulk with the degree of beating is linear and is independent of consistency and the design of beater. This gives a qualitative indication of bonding strength.

5. With same power consumption. freeness and sheet properties were higher with phosphor-bronze tackle irrespective of consistency variation.