Acid Sizing With Calcium Carbonate

An Option To Meet The Technological Challenge For Manufacturing High Quality Printing Paper In Small And Medium Paper Mills

Patel M., and Panigrahy J.C.

ABSTRACT:-- The salient features of a new process for producing surface coated calcium carbonate, suitable to be used in acid sizing process have been outlined. The high brightness and superior printing performance of paper sizing with calcium carbonate compared to other pigments have been brought out. The initial properties of PCC, GCC and the surface coated GCC have been discussed. The strength, cobb value, drainage time, brightness, opacity, smoothness and porosity of hand sheets prepared with the surface coated calcium carbonate with alum-rosin systems have been presented.

It is explained that because of production of low brightness pulp in small and medium paper mills, this product can be specially used for improving the paper brightness and printability properties.

INTRODUCTION

Small and medium paper mills normally can not afford to adapt bleaching processes with chlorine dioxide or ozone. Use of hydrogen peroxide or other such new bleaching processes to improve pulp brightness are also not followed in these mills and only CEH(H) bleaching sequence is employed, As a result of which the pulp brightness in particular remains very low ie. around 65-70% El because of CEH(H) bleaching.

The final pulp bringhtness is improved to some extent by mixing imported soft wood which is quite costly. It may be imperative to use special filler materials for increasing the brightness and to attain superior printing properties. The new process through which surface coated calcium carbonate is produced is thus the appropriate option to meet the technological challenge. In a low brightness (66% El) pulp, 5-7% El increase in brightness and significant improvement in printing performance of the paper using this surface coated calcium carbonate has been claimed (1).

The stock preparation in majority of Indian paper mills is carried out with alum and rosin where the pH is 4.5 to 5. Because of acid medium, fillers like talc and clay are normally used. Calcium carbonate cannot be used because of mismatch of pH though its advantages over other fillers are well known, namely brightness, opacity and ink receptivity. In alkaline media, calcium carbonate can be used without any problem but in stead of alum and rosin, AKD (Alkyl).

EXPERIMENTAL

Pulp

The bamboo-mixed hard wood (80:20) bleached kraft refined pulp (40°SR) from mill was taken for

Pulp and Paper Research Institute
P.O.: Jaykaypur-765 017
Distt. RAYAGADA (Orissa)

preparing the stock and hand sheets were prepared following to Tappi's method (T-205 : OM 88, 1991). The alum used, has 15.45% of Al_2O_3. The rosin in emulsion form was obtained from mill.

Stock preparation

20 gm OD pulp in 2 lt. of water was taken in a laboratory disintegrator in which the disintegration and mixing of the additives were done using the required sequence. 5 minutes of disintegration is maintained after the addition of each chemical. The pH of the stock at each stage was measured by digital pH meter.

After the stock preparation is completed, the pulp slurry is diluted to 7 lt. of water, from which the required amount is taken for preparation of hand sheets (60 gsm).

The sizing test of hand sheets was conducted by cobb test (T-441 : OM 90, 1991) and cobb values were measured by amount of absorption of water for 1 minute. The physical strength properties have been performed following to Tappi's standard methods (T-220 : OM 88, 1991).

Brightness and opacity values were obtained from Elrepho brightness tester (Carl Zeiss, West Germany). The smoothness and porosity values have been determined in Bendtsen porosity meter (Bendtsen, model-6, Denmark).

The drainage time was recorded by using a stop watch reading upto 1/100 of a second and also following to Tappi's test method (T-221 : OM 88, 1991).

RESULTS AND DISCUSSION

The textural properties of the filler available are very critical for conversion to surface coated products. If the particle size is very very fine, as used in abroad, the coating chemicals fail to develop a coating layer. This is probably because of the particle-particle interaction which is easier in fines (13) than in larger particles. This leads to particle agglomeration and agglomerated particles are difficult to be coated all over the surface as the whole surface of each particle cannot be reacted with the coating chemical.

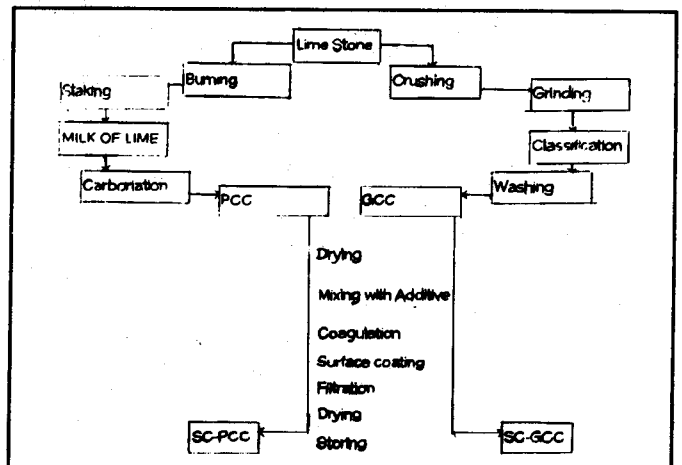


Fig.-1: Preparation of SC-PCC and SC-GCC

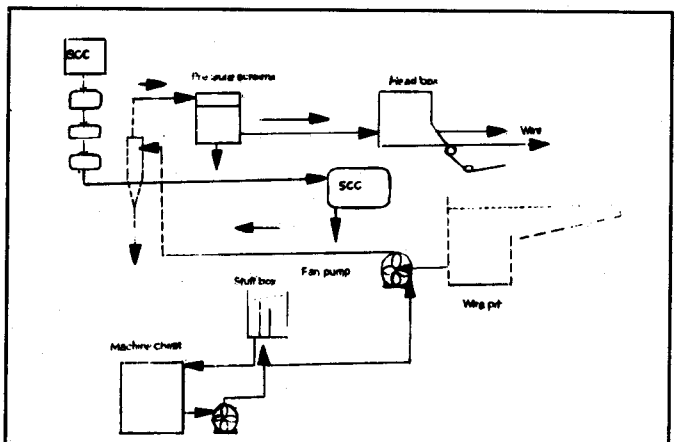


Fig.-2: Flow diagram for SCC preparation and addition

The second important factor is the strength of the particle (Morh's hardness). The particle hardness of GCC is higher than PCC and thus surface coating can be more efficiently made in GCC than in PCC. The chemical purity, BET surface area, brightness, pH of slurry of calcium carbonate are also important. The process for production of surface coated calcium carbonate are shown in Fig. 1 both for GCC and PCC.

Fig.-2 indicates the SCC preparation and addition; (details of preparation are in Fig.-1).

The brightness of initial PCC and GCC are 97.7 and 97.4% El respectively which are lowered by 1% El on surface coating (Table-1). In the same table, pH values of 10% slurry are given which are all in alkaline range. The dispersibility values (14) of PCC is 97% which is little lower in GCC (86%).

Table-1

Properties of Calcium Carbonates

	Brightness (% EI)	*pH	Dispersibility (%)
PCC	97.7	9.70	97.0
GCC	97.4	8.50	85.9
SC-PCC	96.6	9.59	--
SC-GCC-I	96.3	8.44	--

*10% slurry

The analysis result of alum is given in Table-2 and that of rosin in Table-3. The Al_2O_3 content in alum is 15.45%. Though lot of experiments have been carried out, only 7 sets of sizing experiments are described here (Table-4).

Table-2

Analysis of alum

Insoluble matter,	%	:	0.85
pH (5% solution)		:	2.25
Aluminium as Al_2O_3,	% W/W	:	15.45
Basisity as Al_2O_3,	% W/W	:	0.30

Table-3

Analysis of rosin

Property		Value
Specific gravity		1.085
Total solids,	%	1.76
Ash,	%	4.53
Alkalinity as Na_2CO_3,	%	4.24
Total rosin,	%	1.14

Table-4

Composition and pH of different stocks

Set No.	Alum	Rosin	Sizing	Filler	Filler (%) addition	pH
I	3.5	1.0	N	--	--	4.5
II	3.5	1.0	N	PCC	25	4.5
III	3.5	1.0	N	SC-PCC	25	4.5
IV	3.5	1.0	R	SC-PCC	25	4.5
V	3.5	1.0	N	GCC	25	4.5
VI	3.5	1.0	N	SC-GCC	25	4.5
VII	3.5	1.0	R	SC-GCC	25	4.5

(R) Reverse - Alum + Rosin
(N) Normal - Rosin + Alum

In Table-5, the cobb values of top side of the hand sheets are only given along with drainage time. It can be seen in Table-5 that the uncoated pigments have no sizing (Sets II and V). The surface coated PCC (Set III) in normal sizing has also no sizing. However, when the surface coated PCC (Set IV) is subjected to reverse sizing, some sizing occurs; 38.4 g/m² of cobb value. The surface coated GCC (Set VII) in reverse sizing again has poor sizing; cobb value of 43.5 g/m². The best sizing property was observed in Set VI where surface coated GCC has been used in normal sizing.

Table-5

Cobb and drainage values

Set	Cobb* (g/m²)	Drainage time (Sec)
I	15.8	6.47
II	No size	6.60
III	No size	5.28
IV	38.4	5.80
V	No size	6.00
VI	15.8	6.20
VII	43.5	6.81

* Top side values

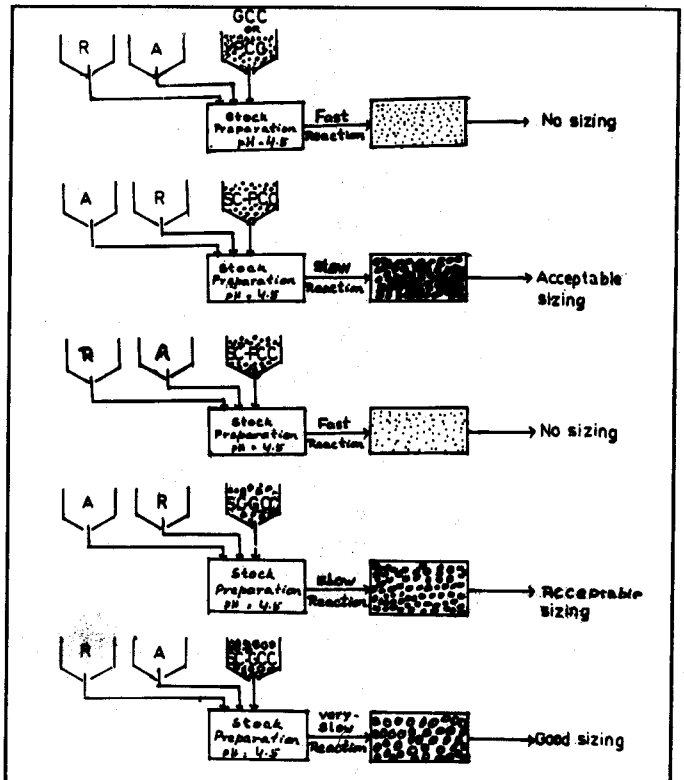


Fig 3 Flow diagram for different stock preparations

As the water as well as chemicals used are all same in the sizing experiments, the properties of pigments play role in deciding the sizing efficiency in normal or reverse sizing. The non-coated pigments present in the hand sheet are immediately attacked by the acid (pH 4.5) and thus present no sizing. As described earlier, the surface coating cannot be carried out efficiently in PCC as compared to GCC because of particle agglomeration in the former and therefore SC-PCC has comparatively higher cobb value (38.4 g/m^2) than SC-GCC (15.8 g/m^2). The reaction mechanisms are schematised in Fig. 3 where the reaction kinetics (Fast, slow or no reaction) have been taken into account The drainage times are all in the acceptable range, with practically no change (5.3 to 6.8 sec).

The optical and surface properties of the hand sheets with different pigments are shown in Table-6. The SC-GCC having best sizing property (Set VI) has brightness of 76.5% El same as in Set VII while the SC-PCC in reverse sizing has brightness value of 77.5% El (Set IV). The opacity values for SC-GCC are 90.3 and 88.8% while for SC-PCC, it is 89.9% which are all on the higher side. The smoothness values of SC-GCC are marginally higher (69 and 68 ml/min.) then in SC-PCC (63 ml/min.). The porosity values of hand sheets with SC-GCC are 300 and 430 ml/min while it is 420 ml/min for SC-PCC.

Table-6

Optical and surface properties

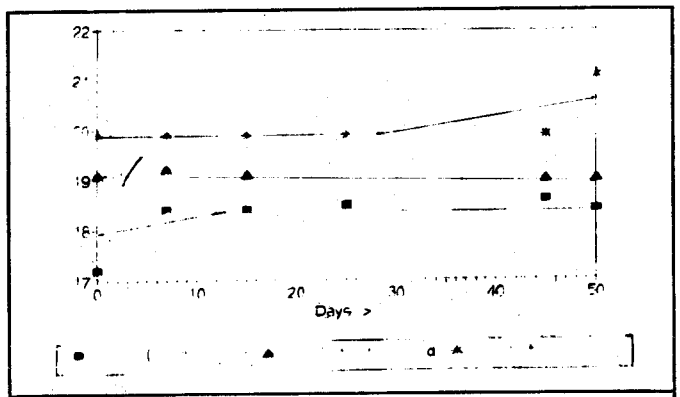
Set No.	Brightness (% El)	Opacity (%)	Smoothness (ml/min)	Porosity (ml/min)
I	74.9	89.9	57	210
II	77.7	91.5	83	290
III	76.9	91.5	76	360
IV	77.5	89.9	63	420
V	78.4	90.5	62	400
VI	76.5	90.3	69	310
VII	76.6	88.8	68	430

Considering all the properties and specially the sizing property which is most important, the order of performance in the seven sets are as follows:

$$SC\text{-}GCC_{(N)} > SC\text{-}PCC_{(R)} > SC\text{-}GCC_{(R)}$$

where N and R indicate normal and reverse sizing.

It is evident from the above results that the mode of sizing i.e. reverse or normal is very specific and it may be variable from pigment to pigment. This conclusion has led us to investigate further in details on mode and mechanism of sizing with talc which will be discussed in a subsequent paper. SC-GCC has been examined further to establish that its properties do not deteriorate with time. It has been stored in glass container and exposed to air upto 50 days and then the cobb values (Fig. 4), brightness and opacity (Fig. 5), bulk (Fig. 6), burst and tear factors (Fig. 7), breaking length (Fig. 8) and double fold (Fig. 9) have been determined. It can be seen that little changes have taken place with in these properties. Fig. 10 indicates the acid resistance property of SC-GCC where the alum consumption has been measured against time at pH 4.5. Obviously, there is little amount of alum is consumed with time i.e. the SC-GCC product surface is alkaline and it is liable to be effected by alum during acid sizing but this reaction rate is very very slow (Fig. 3).



■Blank (no filler) ▲Product not exposed ✳ Product exposed

Fig.4: Cobb values with SC-GCC after storing

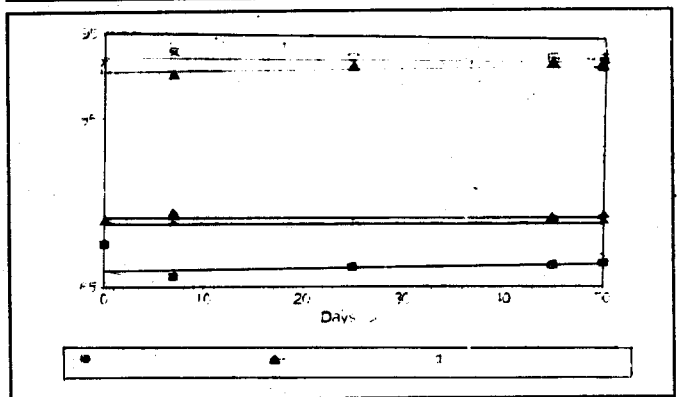


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Fig.5: Brightness and Opacity with SC-GCC after storing

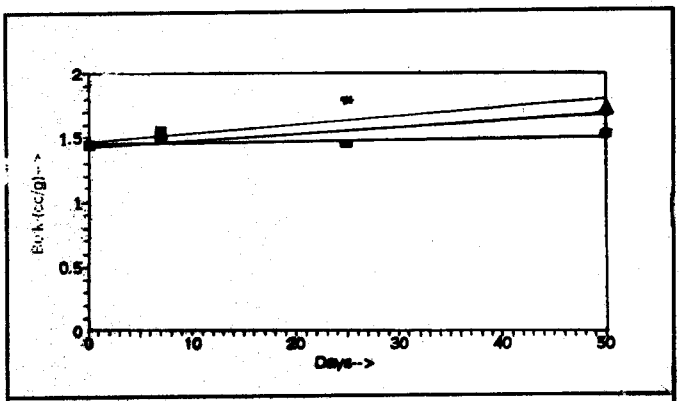

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Fig.6: Bulk of handsheet with SC-GCC after storing

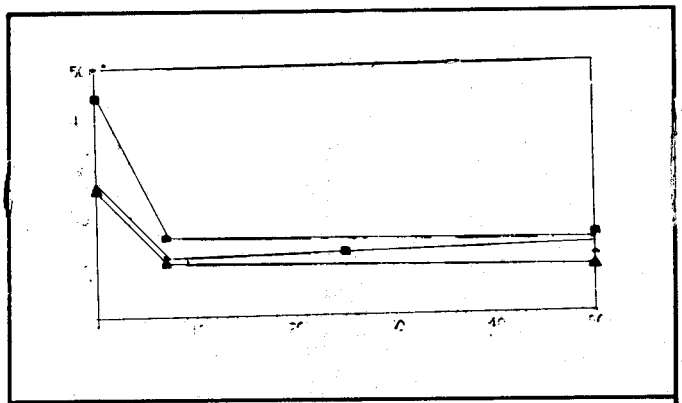

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Fig.9: Double fold (no.) with SC-GCC after storing

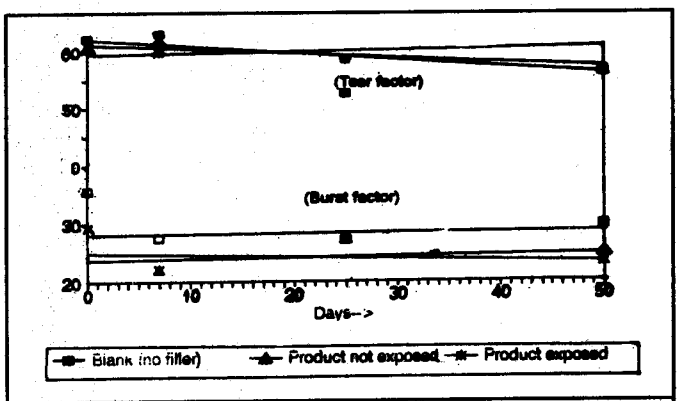

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Fig.7: Burst factor and Tear Factor with SC-GCC after storing

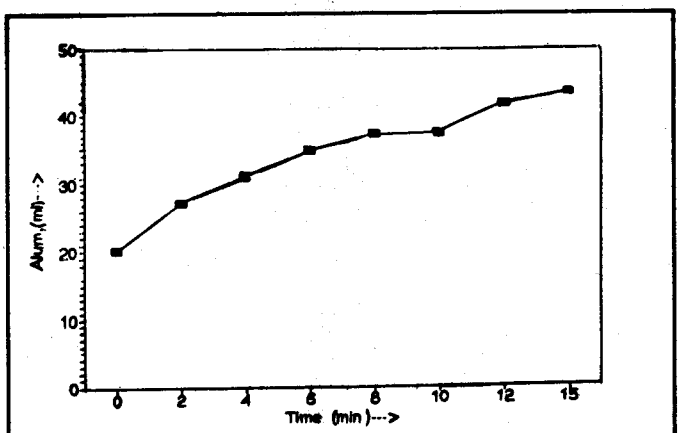
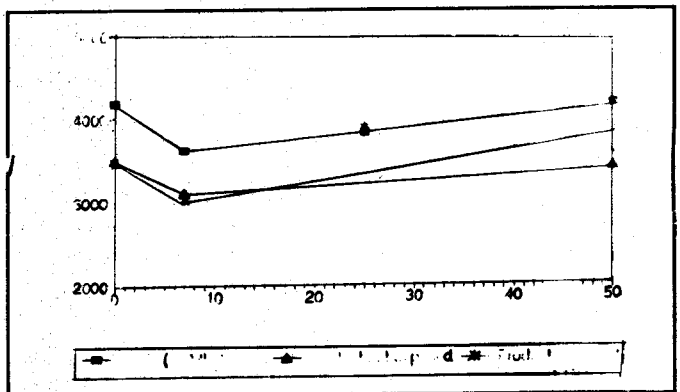


Fig.10: Rate of alum consumption



Blank (no filler) Product not exposed Product exposed

Fig.8: Breaking length with SC-GCC after storing

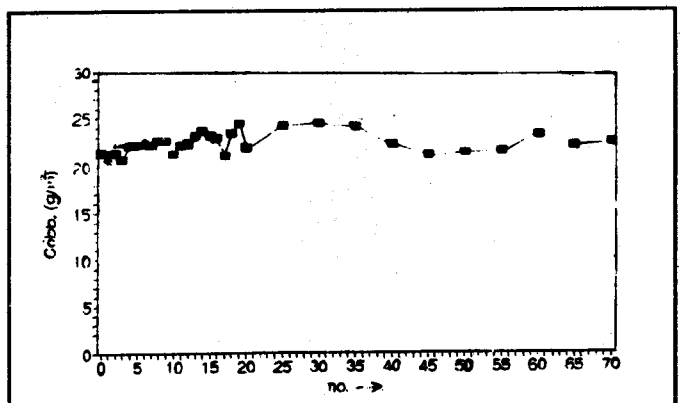


Fig.11: Cobb values after recirculation

In order to further confirm that the SC-GCC does not get deteriorated with time and in the mill process, cobb values of hand sheets after 70 times of circulation have been measured. The results of cobb value against number of recirculation are shown in Fig. 11 and it can be seen that the sizing property is very well maintained even after 70 times of recirculation of back water.

CONCLUSIONS

Surface coated GCC and PCC produced in the patented process can efficiently be used in acid sizing with alum and rosin. Surface coated PCC should be used only in reverse sizing while surface coated GCC can be employed both in normal and reverse sizing. However, surface coated GCC pigment works better in normal sizing. The efficiency of these 3

pigments is in the following order:

$$SC\text{-}GCC_{(N)} > SC\text{-}PCC_{(R)} > SC\text{-}GCC_{(R)}$$

SC-GCC in normal sizing is recommended to be employed in the mill. This pigment does not deteriorate its properties even on exposure to air for 50 days or recirculation for 70 times.

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