Technological Development in wet end sizing for Packaging Grades of Board Making Industries In India



Dr.M.Vadivel
Sarawati Udyog India Ltd,
Velur, TN

S.Sathiakeerti
Sarawati Udyog India Ltd,
Velur, TN

K.Rajaiah
Sarawati Udyog India Ltd,
Velur, TN

Abstract:

The paper industry occupies a prestigious position among the various enterprises globally .In fact, packaging of commodities and commercial valuable goods, make it an indispensable and environmental friendly. Increasing want of paper in the country which is growing at a rate of 6 - 7 % .All over the world for duplex board making mills by using a recycled waste paper have a bright future due to heavy demand raised by packaging, printing Industries and now days by online shopping .Of the total industrial of packaging industries the contribution of duplex board have been accounted as 32%. To achieve better quality board the mill might expand its operational issues from raw material feeding to finishing. To get fly from breakeven point to profit region cost reduction is an important point that is to be monitored and controlled very carefully. In these case studies the plant trial were taken in a board making mill having a cylinder mould operation and also applicable to multilayer Fourdrinier for cost reduction and trouble free operation with the application of colloidal chemistry.

Key Words: Conductivity, Zero liquid discharge, Edge penetration, Wet end sizing, Alum, Rosin, Acid sizing, AKD, ASA, Cobb, Starch, Size press, Surface sizing agent, Precoat, top coat.

1.1.0. INTRODUCTION

The paper industry uses various sizing agents to give degree of resistance to wetting and penetration by aqueous liquids. A series of chemicals were employed to impart size - fiber bonds at various P^H in wet end . The bonding strength have been proved to be dependent upon the type of bonding. In rosin –alum size the size bond is indirect(through an aluminum co -ordinate complex),which is vulnerable to attack by acid , alkali and especially aluminum complex ligands, in which ligand substitutions take place .Alkyl Ketene Dimer (AKD) can react with cellulose to form direct β-Keto ester bonds. About 20-30% of cost is spending for wet end chemicals and nearly 40 % of cost is accounted for drying operation. Wet end chemicals cause a serious quality issue even at customer end. Care must be taken while choosing the wet end chemicals. Another important point is to be noted that usages of back water must be restricted /avoided for chemical preparation. Many board mills in India use the back water for chemical preparation i.e. Spray starch, retention aid preparation which affects the efficiency of these chemicals. Another important point is to be noted that in India small importance for laboratory / Research and development is considered even at a large scale integrated pulp and paper industry. Many small scale board making mills in India have Cobb and brightness tester only. To get a cost effective and customer supportive feedback, each and every mill should consider the lab activities for its sustainability and survival in forthcoming years.

1.1.1. SCOPE OF THE STUDY

The present study has focused on the corrosion of wet end equipments, breaks, cleaning frequency, wet end fabric damage and changing time. It was found that almost all equipments gets corrosion due to the application of alum or Poly aluminum chloride (PAC).The following images show the impact of the above chemicals. It was decided that to save the equipments of fourdrinier machine as well as cylinder mould machines, the serious plant study was taken out.

Fig No: 1 : Corrosion of SR box

Fig No: 2 : Corrosion of SR box

Fig No: 3 : Corrosion of Moulds

Fig No: 4, Corrosion of Machine Bed

1.1.2. MATERIALS AND METHODS

Three months plant study (from 01.02.2016 to 30.4.2016) was conducted in a board making mill operating at the speed of 150-250 mpm .The furnish was fixed as 60 % Imported SOP, 20% Note book and 10% White record, 10% local for top layer and 50 % colour record, 50% Tamil newspaper, for bottom layer 40 % mill broke 60% Indian mixed waste. All the sizing agents' and other wet end chemicals quantity was measured very carefully and noted down. The couch, press break, corrosion, before size Cobb, final board was considered as a prime tool and the wet end fabric cleaning frequency was considered as a secondary tool.

1.1.3. CHEMISTRY OF SIZING

In modern usage, the term “Sizing” indicates the process in which a chemical additive provides paper and paper board with resistance to liquid wetting, penetration and absorption. Because the aqueous fluids (i.e. ink, water and milk) are generally the liquids of concern; the purpose of sizing is to produce water repellency. Further many papers such as office papers, packing papers like papers used for grocery bags, cereal boxes etc should be able to resist accidental wetting during use [1].

1.1.4. TYPES OF SIZING PROCESSES

There are two types of sizing processes. They are,

1. Internal sizing
2. Surface sizing

1.1.5. INTERNAL SIZING

Because cellulose is highly hydrophilic (water loving) material, and pulp fiber surface have a high specific energy, water readily wets these surfaces. The very porous nature of the paper makes it act like a sponge, so that the unsized paper soaks up or wicks aqueous liquid very rapidly and extensively. Sizing agents provide paper with reasonable resistance to these actions by liquids especially water. The penetration is governed by Washburn equation. Two of the five parameters which govern the rate of flow (surface tension and viscosity of the liquid) are determined by the ultimate customers' needs. Two more parameters (radius and length of the pores) are governed by paper makers' product i.e. basis weight, bulk density and porosity of the sheet. Thus in offset printing, especially web offset even unsized papers do not give any problems as the ink is oil based and the initial contact angle is high.

1.1.6. CHEMISTRY OF ACID SIZING

Acid sizing agents are intended for use in acid papermaking systems, traditionally less than pH 5. Rosin size under acid conditions has been the most widely used sizing agent since sizing technology was developed in 1807. Unfortunately, acidic sizing has several drawbacks, such as yellowing and embrittlement of paper, machine corrosion, and strength losses. In fact, many mills have shifted their papermaking conditions from acidic to neutral-alkaline region for higher strength and increased longevity of archival papers. It also allows mills to use calcium carbonate fillers in making printing paper. Aluminum oxide, or alumina, is listed as being insoluble in water, and only very slightly soluble in acid and alkali [2]. In fact, the solubility of aluminum compounds in general is pH dependent. As fig 1 indicates ,aluminum cab exists can exist in at least five forms, depending upon pH[3] these five forms, the completely soluble form is the Al^{3+} form that exists at a low pH (generally below pH = 4.5). Figure 2 examines just the lower pH portion of the curve, and indicates that the soluble fraction reaches its maximum at a pH below 4. Curves may be shifted left or right depending upon changes in aluminum concentration, temperature, etc [4]. The reaction mechanism of alum – rosin sizing is shown fig no: 3.The consumption of alum is directly depend on the total hardness of process water and conductivity of backwater (If hardness more than 100 ppm as ca hardness) *acid sizing* lose its efficiency.

Fig No: 5 Alum existing forms

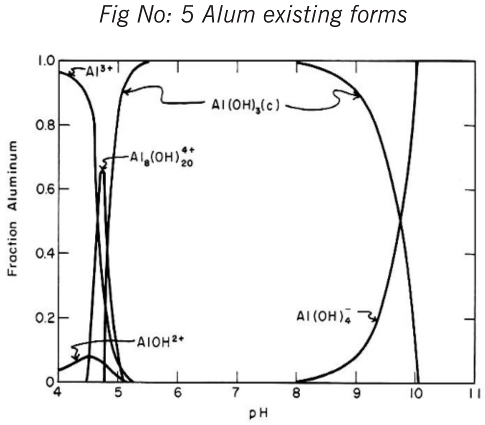


Fig No:6 Alum versus P^H

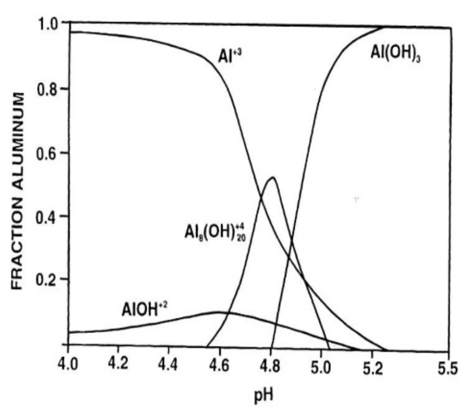
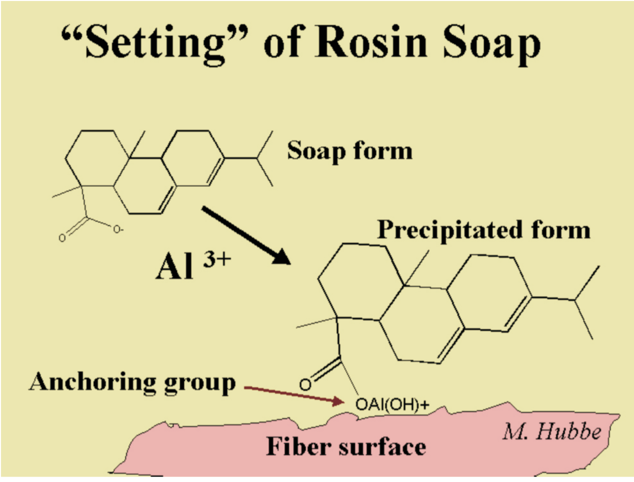


Fig No: 7, Reaction mechanism of acid sizing

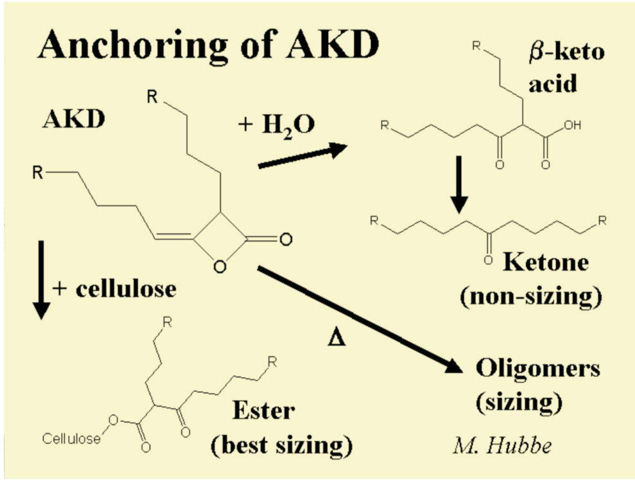


Many board makers claim that the acidity which has to be maintained at the level of 150-250 ppm for board which is not necessary. Acidity is only applicable for writing and printing papers which causes ageing / yellowing effect. And also there is no direct relationship between acidity and runnability of mould or wire machine for board making. Acid sizing creates heavy foam with "Ca" containing fillers.

1.1.7. CHEMISTRY OF AKD SIZING

Sizing agents for papermaking systems above pH 6.5 are generally based on alkyl ketene dimer (AKD) and alkenyl succinic anhydride (ASA). AKD sizing very sensitive to process water hardness and temperature of the pulp. For poor water (high hardness water, more than 300 ppm of ca hardness) small amount of alum is added to the system as like metal ion catcher. But the same concept was introduced as binary sizing for MG variety by S.K.Paul [5].It was studied that addition of alum to AKD leads to the formation of Al $(OH)_3$ products which directly affects the runnability of the machine and spoil the wet end clothes, reported by M.vadivel[6].For AKD sizing at least one paper machine dryer temperature should be higher than 95°C which gives better on machine sizing .Wet end alkalinity 150- 250 ppm is to be maintained for AKD sizing without fail to avoid fugitive sizing after manufacturing. AKD sizing allows the application of $CaCO_3$,, PCC, GCC filler. Maintain a required amount of FPFR / FPAR, alkalinity, porosity, dryer temperature and Size press starch viscosity are the critical parameters to avoid feathering of inks on AKD paper.

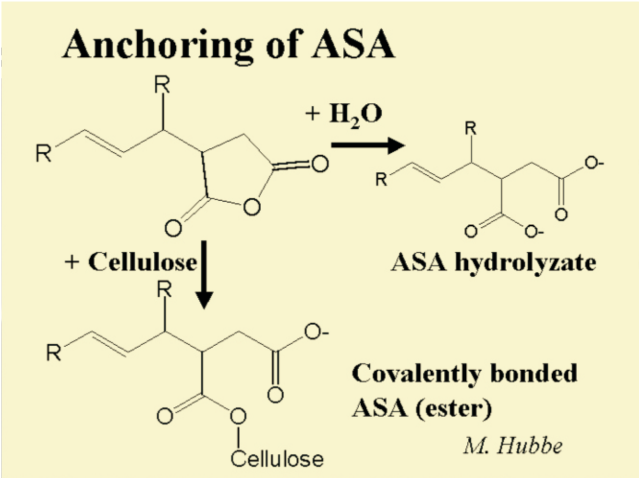
Fig No: 8, Reaction mechanism of AKD with cellulose



1.1.8. CHEMISTRY OF ASA SIZING

The key goals in using ASA are (a) avoid hydrolysis, (b) distribute it well in the furnish, and (c) retain it efficiently. Hydrolysis is minimized by preparing the emulsion as late as possible - usually only seconds before the material is added to the thin stock. The cationic starch solution used in preparing the emulsion may be reduced in pH with the addition of such materials as adipic acid or alum, and it is usually cooled to some degree relative to its cooking temperature. A net ratio of about 3 to 5 parts cationic starch per part of ASA oil usually yields the most efficient sizing. To avoid excessive molecular chain cleavage of this starch, only a part of it is passed through the high shear zone of the emulsifier. Microscopic images (or other methods) can show whether one has achieved the desired narrow size distribution of droplets, usually with an average size near or below one micrometer. The recommended point of addition is after the hydrocyclone cleaners. Although the cationic starch sheath around each ASA droplet has some effect in attaching the size to cellulosic materials, a good retention aid system is needed to achieve relatively high first-pass retention. Due to high conductivity and temperature of stock, ASA loses its binding tendency on cellulose and then the ASA will follow the white water circuit, giving it time to decompose. Deposit problems usually can be minimized by such practices as limiting the dosage (often to within 2.5 lb/ton in the case of virgin bleached Kraft furnish), having alum or PAC present somewhere in the system, turning off the ASA flow during wet breaks, and maintaining good retention.ASA reaction mechanism is shown below .

Fig No : 9 : Reaction mechanism of ASA with cellulose



1.1.9. PLANT TRIAL

With the existing raw material and operating conditions plant trials were taken in cylinder mould machine. The trial conditions like furnish ratio, machine speed, gsm and other operation parameters was maintained as like regular operation. To get rid off from the corrosion and also cost reduction group discussion was held with various suppliers .As recommended by the supplier alum was replaced by Polyaluminum chloride (PAC).After PAC addition again corrosion was found. Finally it was found that, **PAC** had been supplied from **pharmacy residue** which has high corrosive tendency, more than alum. The following images show the impact of PAC in press part, wet end clothes and dryer surfaces as well as wet end area.

Fig No: 10 press shell damage

Fig No: 11 Felt damage

Fig No: 11 Dryer surface damage

Fig No: 12 Dryer surface damage

It was decided to stop both alum and PAC addition and plant trial was taken to maintain the final cobb on board by concentrating surface sizing. Surface sizing agent was selected as PAC free.

1.1.10. RESULTS AND DISCUSSION

Initially the back water conductivity of the system was measured as 15000- 25000 µS/ cm. Based on the wet end chemistry first cationic starch addition was stopped and the machine runnability, quality of board was monitored. After stopping the cationic starch no system imbalance was found. The reason is the cationic starch loses its binding activity on cellulose if the alum or PAC dosage is more than 2 % and also the back water conductivity (6) is more than 5000 µS/ cm. During this plant trial the following furnish ratio was maintain to conclude the trial result with 10 % deviation.

Furnish : Top layer – 60 % SOP, 20 % Note Books, 10 % White Record, and 10 % Local

Filler layer – 50% Colour Record, 50 % Tamil newspaper

Bottom layer– 40 % ONP, 60 % Indian Mixed Waste

The retention was maintained for top layer as 65-75%, for filler layer as 50-55 % and bottom layer as 45-50% with dual polymer system .pH was maintained for all layers from 6.5 -6.8. Precoat weight, top coat was maintained as 8-10 gm and 10-13gm respectively. All the board properties were found as equal to the norms. Cationic starch addition 5 kg / t of board was discontinued for trial run I.

Trail run I explains the impact of eliminating the cationic starch from the system. It was introduced to bind the anionic traces which are present in the system. But this cationic function was hindered by high conductivity. It increases the COD in the final effluent. So the first trial was started with the elimination of cationic starch in the system .The PAC addition was reduced from 30 kg / t of board to 28 kg / t of board. The wet end sizing agent was abridged from 12 kg / t of board to 10 kg / t of board. Top layer Cobb was maintained in-between 29 – 39 gsm and Bottom board Cobb as like 40 - 48 gsm. Before size press cobb was tested and reported as minimum 236 gsm and maximum as 400 gsm. During the trial run I the conductivity was found in the range of 15600 µS/ cm – 25670 µS/ cm.

Trial Run I: Machine Runnability after elimination of cationic starch

Break Analysis per day without cationic starch Month – May - 2016									
Process control Parameters						Wet end Additives kg/T			
Date	Gsm	Press Break	MG Break	Before size press cobb	Final Board cobb T/B	PAC kg/t	Sizing agent kg/t	Cationic starch kg/T	Back water Conductivity μS/ cm.
01.05.16	250	8	4	236	30 / 40	30	12	0	15800
02.05.16	250	12	4	268	32 / 43	30	12	0	20000
03.05.16	400	9	2	356	31 / 40	30	12	0	17900
04.05.16	320	10	6	350	30 / 45	30	12	0	18900
05.05.16	300	14	5	278	32 / 41	30	12	0	21000
06.05.16	300	17	8	356	32 / 45	30	12	0	17890
07.05.16	250	14	8	400	29 / 40	30	12	0	18900
08.05.16	260	18	4	289	36 / 44	30	12	0	20000
09.05.16	285	12	8	350	38 / 44	30	12	0	21000
10.05.16	300	10	4	289	30 / 45	30	12	0	18900
11.05.16	320	13	7	329	33 / 40	30	12	0	19200
12.05.16	265	12	4	300	31 / 44	30	12	0	20050
13.05.16	285	14	8	389	34 / 43	30	12	0	25670
14.05.16	320	11	4	278	32 / 45	30	12	0	18560
15.05.16	260	15	9	285	31 / 44	28	10	0	19800
16.05.16	300	12	4	289	36 / 48	28	10	0	16590
17.05.16	350	14	9	310	39 / 45	28	10	0	17890
18.05.16	320	12	4	320	32 / 40	28	10	0	22000
19.05.16	310	18	9	300	33 / 45	28	10	0	21760
20.05.16	300	14	4	378	31 / 45	28	10	0	20870
21.05.16	320	14	4	350	30/ 40	28	10	0	18790
22.05.16	300	10	4	356	30 / 42	28	10	0	18800
23.05.16	320	9	6	310	30 / 44	28	10	0	18790
24.05.16	300	8	4	324	30 / 44	28	10	0	21900
25.05.16	250	9	4	300	32 / 43	28	10	0	22000
26.05.16	300	9	4	286	31 / 44	28	10	0	25000
27.05.16	310	10	3	288	33 / 40	28	10	0	19860
28.05.16	350	7	4	290	31 / 40	28	10	0	20000
29.05.16	310	8	3	290	30 / 40	28	10	0	18900
30.05.16	300	8	4	285	30 / 41	28	10	0	20170

Water penetration = 90-140gsm

Trial Run II: Machine Runnability after elimination cationic DSR

Break Analysis per day without cationic DSR –Month -June -2016									
Process control Parameters						Wet end Additives kg/T			Back water Conductivity µS/ cm.
Date	Gsm	Press Break	MG Break	Before size press cobb	Final Board cobb T/B	PAC kg/t	Sizing agent kg /t	Catioinc DSR kg/T	
01.06.16	285	6	3	250	31 / 42	28	10	0	15200
02.06.16	260	10	3	260	33 / 44	28	9	0	18000
03.06.16	350	8	1	335	30 / 42	28	9	0	17300
04.06.16	310	6	5	335	32 / 43	28	9	0	17900
05.06.16	290	12	6	267	31 / 40	28	9	0	20000
06.06.16	320	15	7	347	31 / 43	27	9	0	17500
07.06.16	285	12	6	378	30 / 42	27	9	0	18000
08.06.16	350	15	3	267	32 / 42	27	9	0	19000
09.06.16	280	11	7	330	32 / 43	27	9	0	20000
10.06.16	350	11	4	278	31 / 42	27	9	0	18300
11.06.16	310	12	6	330	32 / 40	26	8	0	19100
12.06.16	250	11	3	320	33 / 41	26	8	0	19050
13.06.16	300	12	6	376	32 / 42	26	8	0	20670
14.06.16	310	10	6	259	30 / 43	26	8	0	18460
15.06.16	280	12	5	256	32 / 42	26	8	0	18800
16.06.16	290	11	7	296	33 / 44	26	8	0	16530
17.06.16	340	12	8	300	32 / 43	26	8	0	17590
18.06.16	310	11	6	336	31 / 42	25	8	0	21000
19.06.16	310	16	8	337	33 / 43	25	8	0	20760
20.06.16	380	12	6	346	32 / 43	25	7	0	20890
21.06.16	300	12	5	353	33 / 41	25	7	0	18880
22.06.16	285	9	3	325	31 / 41	25	7	0	17680
23.06.16	300	8	4	330	32 / 41	25	7	0	17690
24.06.16	365	7	5	310	32 / 42	24	7	0	20900
25.06.16	280	6	4	329	30 / 40	24	7	0	21800
26.06.16	285	9	4	265	31 / 40	24	7	0	20840
27.06.16	290	9	5	275	33 / 42	24	7	0	19820
28.06.16	300	6	4	285	32 / 40	24	7	0	18670
29.06.16	320	6	3	276	32 / 41	24	7	0	18900
30.06.16	295	5	2	287	31 / 42	24	7	0	19050

Water penetration = 75-120gsm

Trial Run III: Machine Runnability after increasing (0.3 kg) Surface sizing agent

Break Analysis per day with 0.3 kg/ t surface sizing agent increase – Month- August -2016									
Process control Parameters						Wet end Additives kg/T			Back water Conductivity µS/ cm.
Date	Gsm	Press Break	MG Break	Before size press cobb	Final Board cobb T/B	PAC kg/t	Sizing agent kg /t	Surface sizing agent kg/t	
01.07.16	300	4	2	232	30 / 41	24	7	3.0 +**0.3**	14000
02.07.16	300	5	2	240	31 / 41	23	7	3.0 +**0.3**	16000
03.07.16	350	5	1	310	32 / 41	23	7	3.0 +**0.3**	17000
04.07.16	350	4	3	320	31 / 40	23	6	3.0 +**0.3**	15900
05.07.16	400	4	3	245	31 / 42	23	6	3.0 +**0.3**	16000
06.07.16	420	3	5	280	31 / 41	23	6	3.0 +**0.3**	18450
07.07.16	400	3	3	310	30 / 41	23	6	3.0 +**0.3**	16500
08.07.16	330	4	2	286	32 / 41	22	6	3.0 +**0.3**	18000
09.07.16	285	6	2	339	32 / 43	22	6	3.0 +**0.3**	19640
10.07.16	285	6	3	234	31 / 41	22	6	3.0 +**0.3**	17300
11.07.16	300	5	2	310	32 / 40	22	6	3.0 +**0.3**	18100
12.07.16	260	7	3	289	31 / 41	22	6	3.0 +**0.3**	18050
13.07.16	285	5	2	310	32 / 42	22	6	3.0 +**0.3**	19670
14.07.16	300	5	4	285	30 / 42	22	6	3.0 +**0.3**	17460
15.07.16	250	6	3	236	32 / 42	22	6	3.0 +**0.3**	17800
16.07.16	200	9	2	220	31 / 42	22	6	3.0 +**0.3**	16130
17.07.16	200	5	5	289	32 / 43	22	6	3.0 +**0.3**	16590
18.07.16	200	6	3	334	30 / 43	21	6	3.0 +**0.3**	19000
19.07.16	200	8	6	325	32 / 43	21	5	3.0 +**0.3**	18760
20.07.16	250	5	4	335	31 / 43	21	5	3.0 +**0.3**	19890
21.07.16	250	6	4	367	32 / 43	21	5	3.0 +**0.3**	16880
22.07.16	270	7	3	356	32 / 42	21	5	3.0 +**0.3**	17680
23.07.16	285	6	2	336	31 / 42	21	5	3.0 +**0.3**	16690
24.07.16	300	5	3	376	32 / 42	21	5	3.0 +**0.3**	18900
25.07.16	300	6	4	335	32 / 42	21	5	3.0 +**0.3**	20800
26.07.16	300	5	3	312	32 / 41	21	5	3.0 +**0.3**	18840
27.07.16	320	5	3	325	33 / 41	21	5	3.0 +**0.3**	18820
28.07.16	320	7	4	256	33 / 40	21	5	3.0 +**0.3**	16670
29.07.16	300	5	5	268	33 / 42	21	5	3.0 +**0.3**	18900
30.07.16	300	4	3	264	30 / 41	21	4	3.0 +**0.3**	18050

Water penetration = 80-130gsm

Trial Run IV: Machine Runnability after increasing (1.0 kg) Surface sizing agent

Break Analysis per day with 1.0 kg/ t surface sizing agent increase –Month-August -2016									
Process control Parameters						Wet end Additives kg/T			Back water Conductivity μS/ cm.
Date	Gsm	Press Break	MG Break	Before size press cobb	Final Board cobb T/B	PAC kg/t	Sizing agent kg /t	Surface sizing agent kg/t	
01.08.16	320	2	2	230	30 / 40	20	3	3.0 +**1.0**	13000
02.08.16	310	2	1	220	31 / 40	20	3	3.0 +**1.0**	15000
03.08.16	300	3	0	300	32 / 41	20	3	3.0 +**1.0**	16000
04.08.16	300	2	1	310	31 / 40	20	3	3.0 +**1.0**	14900
05.08.16	300	3	2	285	31 / 40	19	3	3.0 +**1.0**	14000
06.08.16	410	2	1	256	31 / 41	19	3	3.0 +**1.0**	17450
07.08.16	285	1	2	323	30 / 41	19	3	3.0 +**1.0**	13500
08.08.16	310	2	1	245	32 / 41	19	3	3.0 +**1.0**	16000
09.08.16	300	1	2	378	32 / 42	19	3	3.0 +**1.0**	17640
10.08.16	310	2	2	245	31 / 41	19	3	3.0 +**1.0**	14300
11.08.16	320	3	1	323	32 / 40	19	3	3.0 +**1.0**	13100
12.08.16	300	3	1	283	31 / 41	19	3	3.0 +**1.0**	13050
13.08.16	250	4	2	300	32 / 40	19	3	3.0 +**1.0**	14670
14.08.16	250	3	1	285	30 / 42	19	2	3.0 +**1.0**	16460
15.08.16	285	2	2	232	32 / 41	19	2	3.0 +**1.0**	17800
16.08.16	250	4	2	210	31 / 42	19	2	3.0 +**1.0**	17130
17.08.16	300	5	3	268	32 / 41	19	2	3.0 +**1.0**	14590
18.08.16	310	3	2	310	30 / 40	19	2	3.0 +**1.0**	18000
19.08.16	320	5	2	314	32 / 43	18	2	3.0 +**1.0**	17760
20.08.16	300	4	3	310	31 / 40	18	2	3.0 +**1.0**	18890
21.08.16	285	5	3	334	32 / 41	18	2	3.0 +**1.0**	15880
22.08.16	285	3	4	334	32 / 40	18	2	3.0 +**1.0**	15680
23.08.16	280	2	1	321	31 / 42	18	2	3.0 +**1.0**	15690
24.08.16	285	3	1	312	32 / 41	18	2	3.0 +**1.0**	17900
25.08.16	400	3	2	300	32 / 40	18	2	3.0 +**1.0**	19800
26.08.16	420	3	3	324	32 / 40	18	2	3.0 +**1.0**	16840
27.08.16	410	3	3	310	33 / 42	18	2	3.0 +**1.0**	17820
28.08.16	400	4	1	286	33 / 42	18	2	3.0 +**1.0**	17670
29.08.16	385	3	3	284	33 / 40	18	2	3.0 +**1.0**	17900
30.08.16	320	4	4	260	30 / 41	18	1	3.0 +**1.0**	16050

Water penetration = 75-140gsm

Trial Run V: Machine Runnability after increasing (2.0 kg) Surface sizing agent

Break Analysis per day with 2.0 kg/ t surface sizing agent increase –Month-September -2016									
Process control Parameters						Wet end Additives kg/T			Back water Conductivity μS/ cm.
Date	Gsm	Press Break	MG Break	Before size press cobb	Final Board cobb T/B	PAC kg/t	Sizing agent kg /t	Surface sizing agent kg/t	
01.09.16	300	2	2	285	30 / 40	18	0	3.0 +**2.0**	12500
02.09.16	350	2	0	250	31 / 40	18	0	3.0 +**2.0**	14600
03.09.16	300	3	0	345	30 / 40	18	0	3.0 +**2.0**	15800
04.09.16	300	0	1	360	31 / 40	18	0	3.0 +**2.0**	14600
05.09.16	300	3	2	320	31 / 40	18	0	3.0 +**2.0**	13000
06.09.16	400	2	1	280	30 / 41	18	0	3.0 +**2.0**	16450
07.09.16	285	1	0	310	30 / 41	18	0	3.0 +**2.0**	15500
08.09.16	310	2	1	280	31 / 40	18	0	3.0 +**2.0**	15600
09.09.16	300	1	2	356	30 / 40	18	0	3.0 +**2.0**	16640
10.09.16	310	0	1	289	31 / 41	18	0	3.0 +**2.0**	14300
11.09.16	300	3	1	300	30 / 40	18	0	3.0 +**2.0**	12300
12.09.16	300	3	1	256	31 / 40	18	0	3.0 +**2.0**	13050
13.09.16	285	4	0	398	30 / 41	18	0	3.0 +**2.0**	13670
14.09.16	285	3	1	267	30 / 40	18	0	3.0 +**2.0**	13460
15.09.16	300	2	2	400	30 / 41	18	0	3.0 +**2.0**	16800
16.09.16	285	0	2	356	31 / 40	18	0	3.0 +**2.0**	15130

Water penetration = 70-130gsm

Problem claimed by Machine Crews :

During I[st] run the following problems was raised by the machine crews. They were, (A) Waviness (B) Top curling. The images are given below.

Problem No; A. Waviness

Problem No; B, Top curling

Solution for problem no: A

Waviness is a surface property which was directly related to profile variation. The concerned parent roll was subjected to profile test variation by 10 x 10 cutter .Order Gsm was 300. The profile variation was found that minimum gsm 285 gsm maximum gsm was 315. Even though it was in the range of $\pm$ **5 %,** in same sheet the one side edge has 285 gsm and opposite have 315 gsm. This higher gsm side sheet automatically came downwards and causes waviness. The moisture, caliper, bulk are direct relationship with gsm. After adjusting the profile variation, no waviness was found. Final packing was done with polyethylene covers followed by gunny bag to avoid weather and seasonal changes impact.

Solution for problem no: B

Top curling was managed with the help of steam trend. Drying of board is not easy as like paper. It is very complicated. Poor drying causes lumpiness, poor gloss, and curling problem to the board .In India many mills gets dryer screen which had been bought as a second hand from the writing and printing paper machines .Even though It's life was over already, the same dryer screen was employed in board machine which causes, dryer mark, poor dimensional stability by itself, difficult to operate by auto guide, surface roughness on board and finally results curling. Top curling problem was adjusted by the steam pressure at top / bottom dryer group respectively. It was instructed to machine / boiler crews to operate / maintain minimum 8 kg / cm^2 for high pressure line and 3.5 kg / cm^2 for low pressure line .Fail to maintain above pressure the working principle of thermo-compressor will severely affect.

Trail run II explains the impact of eliminating the DSR from the system. It was introduced to bind the anionic traces which are present in the system. But this cationic function was hindered by high conductivity. It increases the final TDS the final effluent. So the second trial was started with the elimination of cationic DSR in the system .The PAC addition was reduced from 28 kg / t of board to 24 kg / t of board. The wet end sizing agent was abridged from 10 kg / t of board to 7 kg / t of board. Top layer Cobb was maintained in-between 30 – 33 gsm and Bottom board Cobb as like 40 - 43 gsm. Before size press Cobb was tested and reported as minimum 250 gsm and maximum as 378 gsm. During the trial run I the conductivity was found in the range of 15200 μS/ cm – 21800 μS/ cm. During II^{2nd} run no issue were raised by the machine crews. Quality was found within the norms.

Trail run IIIrd report has created confidence to continue these trial .The PAC addition was reduced from 24 kg / t of board to 21 kg / t of board. The wet end sizing agent was abridged from 7 kg / t of board to 4 kg / t of board. Top layer Cobb was maintained in-between 30 – 33 gsm and Bottom board Cobb as like 40 – 43 gsm. Before size press Cobb was tested and reported as minimum 232 gsm and maximum as 376 gsm. During the trial run IIIrd the conductivity was found in the range of 14000 μS/ cm – 20800 μS/ cm. During IIIrd run no problems were raised by the machine crews. Quality was found within the norms.

Trail run IVth report had been achieved as the PAC addition was reduced from 20 kg / t of board to 18 kg / t of board. The wet end sizing agent was abridged from 3 kg / t of board to 1 kg / t of board. Top layer Cobb was maintained in-between 30 – 33 gsm and Bottom board Cobb as like 40 – 43 gsm. Before size press Cobb was tested and reported as minimum 210 gsm and maximum as 324 gsm. During the trial run IIIrd the conductivity was found in the range of 13000 μS/ cm – 18000 μS/ cm. During IVth run the following problems were raised by the machine crews. Board Quality was found within the norms.

Problem claimed by Machine Crews :

During IVth run the following problems was raised by the machine crews. They were,

C). Size press fiber pick up

D). Size press roll damage

The images are given below.

Problem No; C. Size press fiber pick up

Problem No; D, Size press roll damage

Solution for problem no: C

During the IVth the addition of wet end sizing agent touch 1 kg / t of board. Fiber picking at size press was noticed and eliminated by increasing the surface sizing agent by 1.0 kg / t of board and also surface sizing agent changed

Solution for problem no: D

During the IVth the addition of wet end sizing agent touch 1 kg / t of board. Fiber picking at size press was noticed and eliminated by increasing the surface sizing agent by 1.0 kg / t of board. The surface sizing agents which was supplied by the chemical supplier is dual component. Normally the surface sizing agent is "**Acrylonitrile-Acrylic dispersion with cationic charge**" or "**Anionic styrene – acrylic copolymer dispersion**" .The cationic surface sizing agent was supplied along with the cationic donor which is purely a **PAC** which gives the pH of surface sizing starch solution from 3.5 to 4.5, causes size press roll damage. To save size press rolls surface sizing agent was selected without cation donar as like PAC and the pH was maintained in-between 6.0-6.5.

Trail run Vth report had been achieved as the PAC addition was reduced to 18 kg / t of board. The wet end sizing agent was completely stopped. Top layer Cobb was maintained in-between 30 – 31 gsm and Bottom board Cobb as like 40 – 41 gsm. Before size press Cobb was tested and reported as minimum 285 gsm and maximum as 400 gsm. During the trial run Vth the conductivity was found in the range of 12500 μS/ cm – 16800 μS/ cm. During Vth run the following no problems were raised by the machine crews. Board Quality was found within the norms. Many Board makers feels that wet sizing impart a wet strength, but wet strength paper / board requires only a minimum of 15% of its dry strength.

Hornification

Hornification is the term used to describe the irreversible changes that a fiber undergoes as it is dried and rewet. Hornification is the permanent loss of swellability in cellulose fibers, leading to a loss of fiber flexibility [8]. In general all board makers' opinion is unsized papers, rapid initial wetting of the fibers is the primary cause of poor coating holdout.

On sized paperboard, where hydrophobicity is already provided by internal sizing, capillary pore size appears to be the controlling factor.

For board making base paper porosity[9] which is mainly depending up on the furnish and it is critical parameter which causes the poor coverage on coated surface. During this trial runs sometimes poor coverage was observed, it was not due the elimination of surface sizing, it was due to blade angle variation , loading problem on top coater , poor pressure of blade holder, life of blade , mixing of water while quality changing (low coat weight order , to reduce pick up). Finally before size press cobb is to be fixed by the mill raw material, machine configuration etc. Normal condition is the paper / board should not wrap on the size press rolls. The optimum before size press cobb for recycled board making is 200 – 400 gsm depending upon the grammage and 70 – 100 gsm for virgin , BCTMP (as a filler layer) pulps .

For paper and board making, the process water quality like pH, hardness, turbidity, conductivity is like human heart and also back water quality. +5000 microsiemens of back water, due to higher ionicity of the system it lowers the attraction of opposite charged materials [10].The optimum wet end, operation friendly conductivity was recommended as 1000 - 2000 microsiemens for fourdrinier (all speed range)as well as cylinder mould machines. Back water treatment should be employed for recycling to reduce the conductivity and set right for use at wet end area.

CONCLUSION :

From these trials it was concluded that more than + **5000 microsiemens** of back water conductivity collapse the functioning of all wet end additives which leads to high wet end chemicals consumption and cost of production. It is applicable to fourdrinier as well as cylinder mould. During the trials water penetration was maintained 75- 140 gsm. No difference was found .Cost reduction will be confirmed after 6 months. Utmost care should be taken while selecting the chemicals whether it is needed for operation. All the pulp and paper chemicals have been recommended / invented mostly for virgin pulp and for fresh water only. Common application of paper chemicals will not help to the mill for profit making and sustainability. Whenever possible to avoid the chemical application at wet end makes the healthy environment and trouble free runnability of paper machine (i.e. Changing the dual polymer retention aid (due ions) to single polymer, elimination of pharmacy PAC, etc which help to decrease the corrosion, conductivity of backwater,).Giving importance to lab might be considered as well as suppliers opinion for achieving quality and profitability. Without science the paper / board can be made but quality and profitability will be a question. Zero wet end sizing can be extended to Kraft manufacturing also.

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REFERENCES

1. Dr.G.VenkobaRao., 2005., Unpublished B.Tech. notes., ***"Chemical Technology- with specialization in Pulp and Paper Technology,"*** pp.30-35.
2. R.C.Weast., 1972., "***Hand book of chemistry and physics***" *53rd Edition.*Cleveland, OH: The Chemical Rubber Company Press, p. B-64.
3. P.L.Hayden., and A.J.Rubin., in Rubin, A. J., Ed., 1974., "***Aqueous-Environmental Chemistry of Metals.***" Ann Arbor, Michigan: Ann Arbor Science Publishers Inc., pp.317 – 381.
4. G. L. Jr., in Gess, J. M. and Rodriguez, J. M., Eds., 2005., "***The Sizing of Paper***", *Third Edition.* Atlanta: TAPPI Press, pp. 75 – 13.
5. S.K.Paul.S.Balasubramaniam.,2007.,"***Binary sizing with AKD for manufacturing MG products, ".,***IPPTA J, vol.19., no.4.,p.105.
6. Dr.M.Vadivel., 2014., "***Collision of sizing agents on wet end fabric performance and it's life,"*** IPPTA J., vol .26., no.2., pp.100-103.
7. James BeMiller and Roy Whistler, 2009 ***"Starch chemistry and Technology",*** Food Science and Technology, International Series*.,* p.686.
8. A.D.Bawden.,and R.P. Kibblewhite.,1995., "***Effects of multiple drying treatments on kraft fibre walls".,*** 3rd Research Forum on Recycling CPPA, Vancouver,. pp. 171–177.
9. Y.V.Sood., Sanjay Tyagi., etal., 2010., "***Effect of base paper characteristics on coated Board quality***",Indian Journal of chemical Technology., vol.17.,pp .309-316.
10. Jerome M.Gess and Paul H.Wilson , 2007., "***Sizing : facts and fallacies***" TAPPI Press, p.73.