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TECHNOLOGICAL ADVANCEMENT IN STIFFNESS IMPROVEMENT FOR DUPLEX BOARD MAKING INDUSTRIES IN INDIA

ABSTRACT

Increasing want of paper in the country which is growing at a rate of 6 – 7 % annually demands for increased requirements of raw material which is expected be almost double in next decades. Due to the shortage of paper making raw materials the usage of agro, recycled and other raw materials is inevitable. 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 and printing Industries. In duplex board all customers needs stiffness rather than coating related properties such as gloss, brightness. To achieve better stiffness in the duplex board, the mill might expand its operational issues from raw material feeding to finishing. The use of recycled paper like ONP, corrugated, coated boards severely affect the drainage and other functional properties of board. In this case study the plant trial was taken in a board making mill having a cylinder mould operation , with cationic starch, cationic starch + cationic DSR, Polyethyleneimine(PEI), cationic polyacrylamide copolymers cPAM, anionic polyacrylamide copolymers aPAM, to save the fiber, reduce cost of production and get improved board stiffness with the application of colloidal chemistry.

Key Words : Retention, Retention aids, cationic starch, cationic starch+cationic DSR, cationic+ anionic DSR, cationic starch + cationic polyacrylamide copolymers cPAM, cationic starch + anionic polyacrylamide, copolymers aPAM. DSR- Dry strength resin.

1.1.0. INTRODUCTION

The primary functions of board making process is the processing of waste paper to clean stock of paper making involves number of cleaning to remove contaminants such as plastic bottles , plastic covers, iron clips, latex , wax , inks , etc. Also one of the major technological issues is presence of high level of contaminants in imported waste paper, which requires appropriate process configuration with state-of-art process technologies to produce lean stock.

The raw materials are transported from the waste paper end to mill by lorry or mini vehicle. It is unloaded manually. Each and every gunny bags were opened and inspected by lab person and unloaded in a specific area to avoid the random dumping. Many mills have a good flooring area for top layer as well as bottom, filler layer. Especially for top layer the sorting was carried out very carefully to avoid process deviations. Some mills in India have a deinking system which allows some low grade raw materials into the system. The mill does not have the deinking system only should allow the high bright raw material for top layer. High cost top layer material which is used for board making is given in table No: 1.

Table No. 1: Top Layer Raw materials

Sl No	Top Layer Raw materials
1	Coated Book stock – Imported
2	Sorted Office waste - Imported
3	Printed Office Cut – POC
4	Note Books
5	No : 1 White cuttings
6	Printed Bleached pulp - Imported
7	White Record
8	White Book , cheque book , legdler



Fig No: 1, Imported Waste Paper

Low cost filler and bottom layer material which are used for board making is given in table No: 2.

Table No: 2, Filler and Bottom Layer Raw materials

Sl No	Filler and Bottom Layer Raw materials
1	Box Board cuttings – Imported
2	Old News Paper (ONP), Tamil , English , Malayalam
3	Unsorted SOP –Imported
4	Newsprint – Imported
5	Indian Mixed waste
6	Box kraft
7	Duplex board cuttings
8	Mill broke
9	Cheque Book , Ledgers



Filler Layer Raw material



Bottom Layer Raw material

Fig No: 2, Filler and Bottom Layer Raw materials

1.1.1 RETENTION

Chemicals are often added to the fibrous slurry before the papermaking wire to improve the drainage performance on the machine wire. These chemicals and chemical programs are called drainage aids. Additional benefits, such as fines retention, are also obtained. Papermaking retention aids are used to increase the retention of fines in the web during the turbulent process of draining and forming the paper web. Without adequate retention of the fine solids, they are either lost to the process effluent or accumulate to excessively high concentrations in the recirculating white water loop and cause production difficulties including deposit buildup and impaired paper machine drainage. Additionally, insufficient retention of the fine solids and the disproportionate quantity of chemical additives which are adsorbed on their surfaces reduces the papermaker's ability to achieve necessary paper quality specifications such as opacity, strength (exclusively stiffness), and sizing. The factors affecting the retention are raw materials, technical solutions, and wet end chemistry are given below,

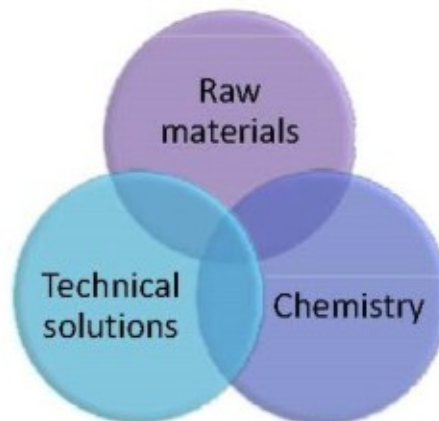


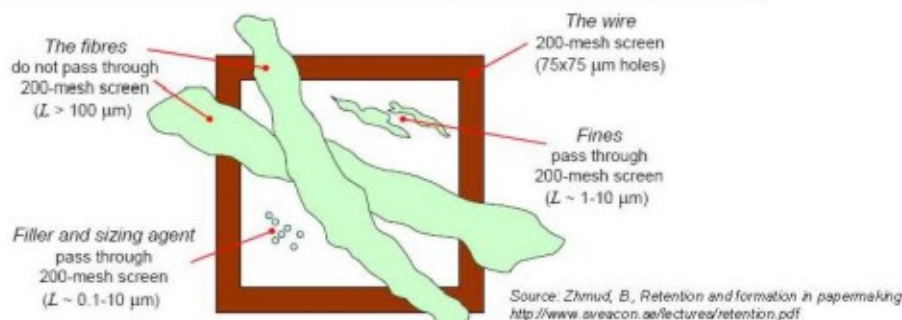
Fig No. 3 : Factors affecting retention

Apart from the above factors unlike the paper making process, duplex board making is entirely different approach needs to understand the wet end chemistry due to the various raw materials employed in this process.

Table No. 3 : Dimensions of paper making components

Dimensions of papermaking components

	Fibers	Fines	Fillers
Length	1 – 5 mm	< 1 mm	0.2 – 3 μm
length/thickness-ratio	50	varying	1 - 5
Specific surface area	1 – 2 m^2/g	3 – 6 m^2/g	6 – 15 m^2/g



1.1.2. CHEMISTRY OF RETENTION

Wet end chemistry is the terminology used in the paper industry to describe the complex interactions among fibers, fibrous components, chemical additives, and the water environment. One aspect of these interactions is the electrostatic attraction among the components. Most chemicals that are added to the papermaking slurry are typically charged and must rely on their electrostatic attraction to the negatively-charged cellulose furnish, to achieve their objectives. Some chemical additives help achieve a final paper quality, while others improve the paper machine runnability.

1.1.3. CHARGE MEASUREMENTS

For the most successful application of charge measurements towards understanding wet end chemistry, one must clearly understand when to use each of the different techniques. Zeta potential measurements help assess the chemical adsorption of additives to fibers and fines, whereas charge demand measurements assess the quantity of dissolved materials in the filtrate. The combination of both measurements helps define when chemical additives adsorb to fiber surfaces, versus when they are consumed by the anionic trash, or interfering substances. Coagulants should reduce anionic trash and disturbing substances bringing the cationic demand closer to zero. Coagulants should not adsorb to the fibers, since this reduces the capacity of the fibers to attract downstream cationic chemical additives. Additionally, anionic trash should not consume functional additives such as starches, dyes, and wet-strength. Functional additives should adsorb onto the fiber surfaces so that they can impart the desired functional quality on the final paper product. The surface charge of the particles should become more positively charged when cationic functional additives adsorb to fibers. When using alum or PAC the charge measurement is a meaningless test because the Al^{3+} have multifunctional role (1).

1.1.4. PLANT TRIAL

With the existing raw material and operating conditions plant trials was taken in

Cylinder mould machine. The trial conditions like furnish ratio, machine speed, gsm and other operation parameters was considered to conclude the effectiveness of this trial programme.

1.1.5. RESULTS AND DISCUSSION

Initially the back water conductivity of the system was measured as 15000- 20000 $\mu S/cm$. Plant trial was taken with the cationic starch which has DS 0.02 - 0.05 at the dosage rate of 5 kg / t of board. The following results were obtained and tabulated below.

Table No. 4 : Cationic starch with / without Retention chemicals

Cationic Starch : 5kg / t of board						
Furnish : Top layer - 60 % SOP , 40 % White Records						
Filler Layer - 40 % ONP , 60 % Local waste						
Bottom Layer - 50 % ONP , 50 % Indian mixed waste						
PAC 30 kg / t , sizing agent 10 kg / t,						
No Retention chemical addition						
Trial run days	Gsm	Speed mpm	Top layer Retention %	Filler layer Retention %	Bottom layer Retention %	Stiffness MD/ CD Taber
1	350	150	45.6	48.3	42.3	100 / 35
2	350	150	51.7	44.0	45.1	105 / 30
3	350	150	53.4	43.5	43.1	110 / 35
4	350	150	50.3	42.3	44.2	105 / 30
5	350	150	56.3	41.4	40.1	115 / 35
6	350	150	51.8	41.9	40.4	110 / 35
7	350	150	52.3	43.2	40.2	100 / 35
8	350	150	52.7	44.8	41.2	110 / 35
9	350	150	52.3	44.2	42.2	105 / 35
10	350	150	50.9	44.3	42.2	110 / 35
With Retention chemical dosage 300 gm / t of board (dual polymers)						
11	350	150	61.2	55.6	55.8	120 / 40
12	350	150	62.3	58.2	56.8	110 / 40
13	350	150	63.1	57.8	57.8	115 / 40
14	350	150	64.2	59.9	57.9	120 / 40
15	350	150	64.2	58.4	58.8	110 / 40
16	350	150	60.1	58.3	58.9	115 / 35
17	350	150	62.3	58.9	58.7	115 / 40
18	350	150	63.2	60	58.7	120 / 45
19	350	150	63.2	61.2	59.8	115 / 40
20	350	150	62.4	61.4	58.7	115 / 40

Table No. 5 : cationic starch +cationic dry strength resin (DSR)

Cationic Starch + cationic dry strength resin (DSR) : Each 5kg / t of board Furnish : Top layer - 60 % , SOP , 40 % White Records Filler Layer - 40 ONP , 60 % Local waste Bottom Layer - 50 % ONP , 50 % Indian mixed waste PAC 30 kg / t , sizing agent 10 kg / t, No Retention chemical addition						
Trial run days	Gsm	Speed mpm	Top layer Retention %	Filler layer Retention %	Bottom layer Retention %	Stiffness MD/ CD Taber
1	350	150	61.2	55.8	56.9	120 / 40
2	350	150	60.5	56.4	56.8	125 / 35
3	350	150	61.5	56.8	56.3	115 / 35
4	350	150	62.7	57.3	58.9	120 / 40
5	350	150	60.5	58.4	57.9	115 / 45
6	350	150	62.1	58.2	58.4	120 / 45
7	350	150	62.7	58.3	58.3	115 / 35
8	350	150	62.8	58.3	58.4	120 / 40
9	350	150	63.5	58.4	58.3	115 / 45
10	350	150	64.2	58.4	58.3	120 / 40
With Retention chemical dosage 300 gm / t of board (dual polymers)						
11	350	150	65.4	60.3	59.8	120 / 45
12	350	150	66.7	60.2	58.9	115 / 45
13	350	150	65.8	60.8	58.5	125 / 45
14	350	150	67.4	60.4	58.9	130 / 45
15	350	150	68.4	60.9	59.9	115 / 45
16	350	150	67.9	61.0	60.1	120 / 45
17	350	150	64.6	60.4	59.9	130 / 45
18	350	150	67.3	60.4	61.2	115 / 45
19	350	150	67.8	61.8	61.2	120 / 45
20	350	150	67.4	62.0	61.4	115 / 45

Cationic starch is commonly used in the papermaking process to increase inter-fiber bonding and to obtain paper strength properties .Starch is added to the thick stock, in the machine chest or stuff box, before the addition of wet-end process chemicals such as drainage aids. Alum and ionic polyacrylamide (PAM), typically anionic polyacrylamide, are also commonly used in papermaking to achieve improvements in drainage and fines retention. These are usually added near the fan pump or head box, before the pulp slurry is deposited on the papermaking wire. Maximum retention efficiency has been achieved if paper is formed after 10 to 20 seconds of retention aid addition.

Alum and ionic PAM are understood to operate (2) by a **“patch model mechanism”**, Alum or PAC operates as the low molecular weight cationic material or coagulant, and ionic PAM acts as the flocculant. The coagulant must be added before the flocculant for effective drainage/retention performance. The starch added after the alum and PAM is independent of any starch previously added to the thick stock. The amount of starch added is in addition to the starch added to provide strength or emulsify internal size. Most papermaking materials become electrostatically charged when dissolved or suspended in water. Depending upon whether discrete particles or dissolved molecules are involved, one is concerned either with *surface charge* or *dissolved charge*. Both play important (3) and different roles in wet end chemistry.

It should be noted that the maximum wet end adsorption is not always achieved with cationic additives as certain conditions (such as high dissolved calcium levels) .The cationic starch adsorption level is shown below at high conductivity .Due to high conductivity the cationic starch was consumed by anionic trashes which is not cost effective. 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 (4) is more than 5000 $\mu\text{S}/\text{cm}$. The adsorption of cationic starch is shown in graph as given below.



Fig No. 4 : Cationic starch adsorption graph

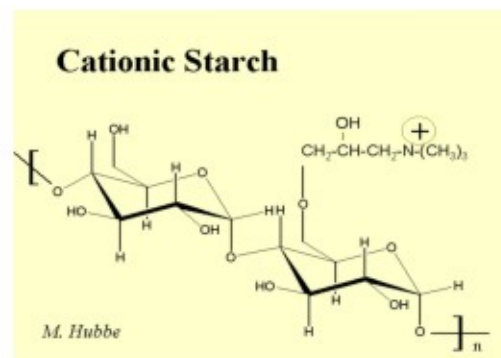


Fig No. 5 : Cationic starch

1.1.6. CHARGE INTERACTIONS

Reactions between cations and anions which may lead to precipitation such as that of calcium carbonate and calcium sulphate. The balance between protons and hydroxyl ions determines the system pH, which has obvious implications in terms of corrosion of construction materials and more subtle effects on the charge of other materials and hence on their interactions. Repulsion between the various particulate solids due to their normal anionic character. Mutual aggregation can occur when the anionic surface charge is reduced by cationic additives or by high electrolyte levels, but the strength of the aggregates thus formed is quite weak and easily broken by shear forces unless some inter-particle bridging is involved between particles and oppositely-charged dissolved solids. This can take the form of a stoichiometric exchange of ions between the surface and the liquid phase or the adsorption of polymers, which may not necessarily be charge-stoichiometric. Adsorption is a very important process in papermaking as it is a crucial step in the retention of many (usually cationic) paper additives and in the functioning of polymeric retention and drainage aids. Between oppositely-charged dissolved polymers, notably between added cationic additives and anionic substances originally present largely in pulps (anionic trash). The components presents in pulp are given below.

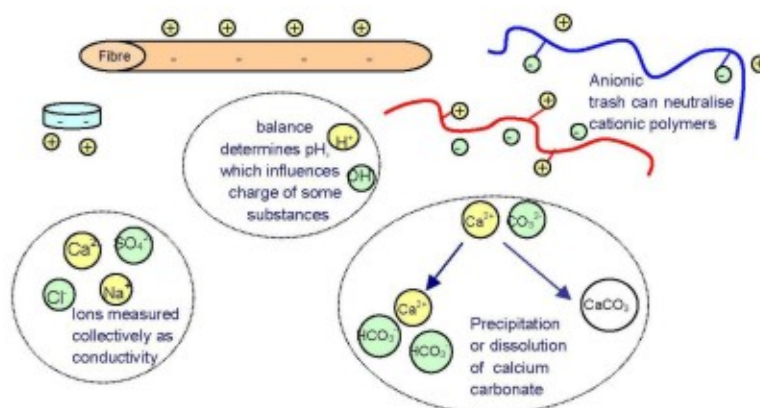


Fig No. 6 : Pulp components

Table No. 6 : Polyethyleneimine (PEI)

Polyethyleneimine (PEI) : 5 kg / t of board						
Furnish : Top layer - 60 % , SOP , 40 % White Records						
Filler Layer - 40 ONP , 60 % Local waste						
Bottom Layer - 50 % ONP , 50 % Indian mixed waste						
PAC 30 kg / t , sizing agent 10 kg / t,						
No Retention chemical addition						
Trial run days	Gsm	Speed mpm	Top layer Retention %	Filler layer Retention %	Bottom layer Retention %	Stiffness MD/ CD Taber
1	350	150	60.2	53.2	55.4	125 / 45
2	350	150	59.5	55.5	55.7	135 / 40
3	350	150	59.5	54.7	55.6	135 / 40
4	350	150	60.7	54.4	56.8	130 / 35
5	350	150	58.5	57.6	55.5	115 / 40
6	350	150	63.1	53.2	55.7	110 / 45
7	350	150	60.7	52.5	53.8	125 / 35
8	350	150	61.3	59.3	54.5	125 / 40
9	350	150	62.1	52.3	56.3	115 / 40
10	350	150	61.2	53.5	56.9	125 / 40
With Retention chemical dosage 300 gm / t of board (dual polymers)						
11	350	150	66.7	61.3	58.7	125 / 40
12	350	150	67.8	63.4	57.6	135 / 45
13	350	150	68.9	61.2	58.6	135 / 35
14	350	150	66.6	62.4	57.4	130 / 45
15	350	150	65.6	61.2	58.9	135 / 45
16	350	150	66.8	60.5	58.1	120 / 35
17	350	150	66.8	60.3	57.9	120 / 45
18	350	150	68.5	61.5	60.2	125 / 35
19	350	150	65.8	61.6	60.2	125 / 35
20	350	150	66.7	61.4	62.4	115 / 45

The chemical structure of polyethyleneimine (PEI) is given below, Synthesis method : acid catalyzed polyaddition.

Chemical Structure of Polyethyleneimine (PEI)

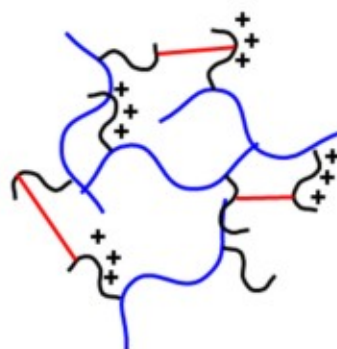
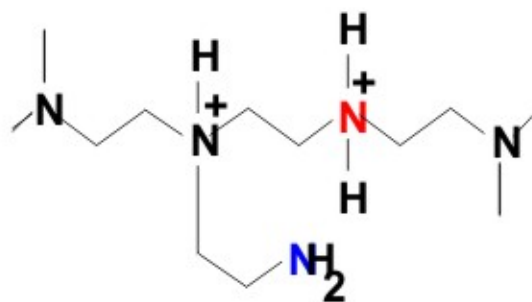


Fig No. 7: Polyethyleneimine Bonding with fiber

When alum or PAC present in the wet end system, the addition of positive charge retentions aids increases the cationicity and the fiber, fines gets deviation from the electrical double layer which leads to weaker the vanderwaals force and hydrogen bonds .From the above results the 5 kg of PEI does not produce the required final result in terms of stiffness and rattling sound of board.

Table No: 7, Catioinc polyacrylamide (cPAM)

Catioinc polyacrylamide (cPAM) 300kg / t of board Furnish : Top layer - 60 % , SOP , 40 % White Records Filler Layer - 40 ONP , 60 % Local waste Bottom Layer - 50 % ONP , 50 % Indian mixed waste PAC 30 kg / t , sizing agent 10 kg / t,						
Trial run days	Gsm	Speed mpm	Top layer Retention %	Filler layer Retention %	Bottom layer Retention %	Stiffness MD/ CD Taber
1	350	150	61.7	55.3	60.3	115 / 35
2	350	150	62.7	55.9	61.4	125 / 40
3	350	150	63.2	58.9	62.5	115 / 35
4	350	150	66.7	59.9	63.6	120 / 35
5	350	150	65.2	60.4	62.4	115 / 30
6	350	150	66.8	60.4	63.5	110 / 40
7	350	150	65.5	62.7	61.3	120 / 35
8	350	150	64.5	59.3	61.4	120 / 40
9	350	150	66.2	60.2	60.3	115 / 40
10	350	150	62.9	61.3	62.6	
cPAM 300 gm / t of board + Polyethyleneimine (PEI) : 5kg / t of board						
11	350	150	68.8	62.4	60.2	135 / 40
12	350	150	69.8	63.3	60.1	135 / 45
13	350	150	67.1	64.4	60.5	135 / 35
14	350	150	65.2	64.3	62.5	130 / 45
15	350	150	66.8	63.6	63.4	135 / 45
16	350	150	65.2	62.1	63.8	140 / 35
17	350	150	69.8	61.0	62.9	130 / 45
18	350	150	67.7	61.9	62.4	145 / 35
19	350	150	66.8	62.5	63.2	145 / 35
20	350	150	69.1	63.5	61.4	145 / 45

The most effective way of minimizing the negative effects of polymeric and colloidal anionic disturbances is to pre-treat the furnish with highly cationic low molecular weight polymers such as polyamines, PEI, or poly-DADMAC or inorganic aluminum species such as polyaluminum chloride. These types of additives are often referred to as anionic trash catchers or fixatives. ATCs reduce the cationic demand of disturbing substances, thus reducing their negative interaction with polymers.

Brouwer has studied the influence (5) of different anionic trash catchers on colloidal material and fines. According to the findings, polyaluminum chloride (PAC) neutralizes first the colloidal material and then the fines, whereas poly-DADMAC acts oppositely. The effects of conductivity (0.31□2.3 mS/cm, from Na₂SO₄) on potential and cationic demand were

studied. At high conductivity, a flatter correlation occurs. Practical experience confirms this hypothesis in that organic ATCs should primarily be selected when the objective is to reduce the cationic demand on the fiber surface (blocking polymer), while inorganic ATC (PAC or alum) should be used when the main objective is to reduce the cationic demand of the disturbing substances. It should also be noted that an organic ATC has a strong negative effect on OBA efficiency (quenching), while a PAC is highly.

The recoiling effect of all polymers is based on the preparation methods. The retention aid (powder or liquid form) addition during the preparation is very slow and steady. The recommended gpl is 1.0 – 1.5. During this plant, the cPAM gpl was maintained as 1.0. The addition point was the pressure screen outlet to avoid the shear force. The results shows that the retention in top, filler and bottom is very low even though 300 gm / t of board. Due the presence of Al^{3+} present in the system and high conductivity cPAM does work well. The recoiled structure of cPAM is shown below.

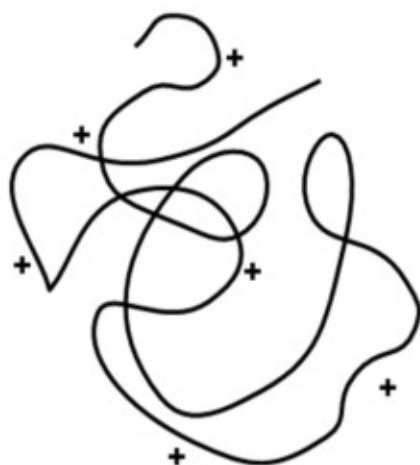


Fig No. 8 : cPAM structure

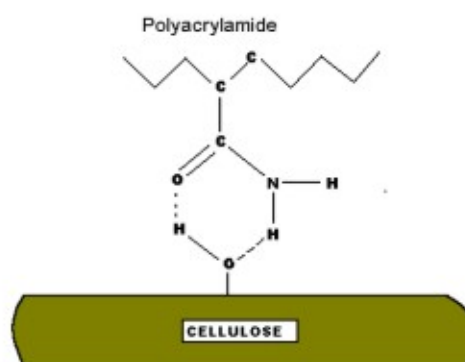


Fig No. 9 : cPAM bonding structure with cellulose by H⁺ Bond

The use of 30 kg of PAC enriches the system with positive charge (cationicity) which hinders the cPAM to adsorb on the cellulose fiber yields a low retention and poor stiffness quality board. The dissolved matter present in the system which indicated by the conductivity hinders the retention of cPAM and reaction mechanism is given below.

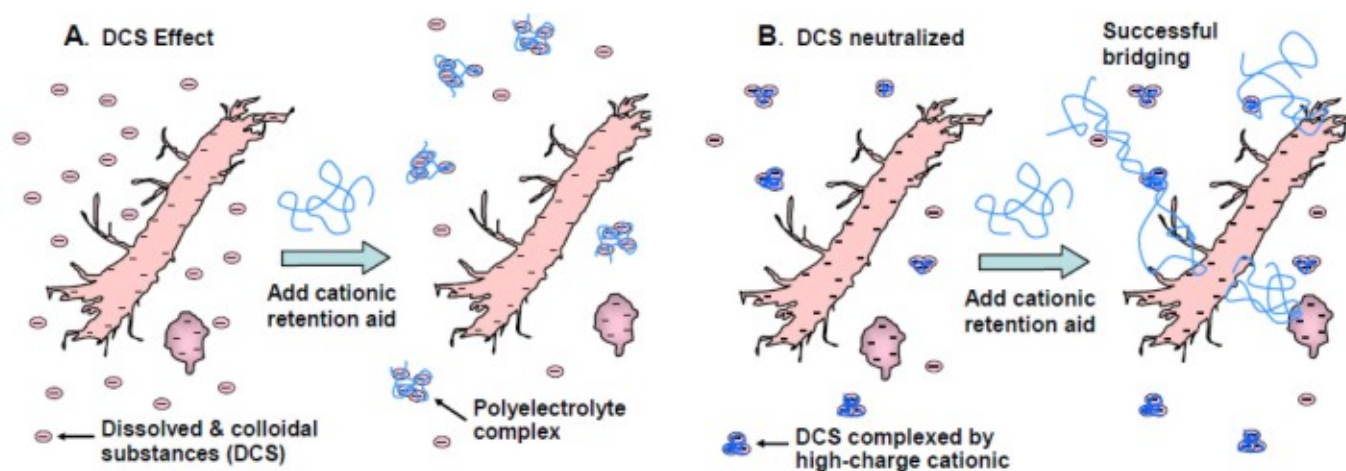


Fig No. 10 : Reaction mechanism of DCM with cPAM

Table No. 8 : Anioinc polyacrylamide (aPAM)

Anioinc polyacrylamide (cPAM) 200kg / t of board						
Furnish : Top layer - 60 % , SOP , 40 % White Records						
Filler Layer - 40 ONP , 60 % Local waste						
Bottom Layer - 50 % ONP , 50 % Indian mixed waste						
PAC 30 kg / t , sizing agent 10 kg / t,						
Trial run days	Gsm	Speed mpm	Top layer Retention %	Filler layer Retention %	Bottom layer Retention %	Stiffness MD/ CD Taber
1	350	150	80.2	77.4	72.3	155 / 65
2	350	150	81.4	75.5	72.5	165 / 60
3	350	150	80.6	78.6	78.3	155 / 55
4	350	150	81.8	79.7	75.2	140 / 55
5	350	150	82.9	78.5	75.8	165 / 60
6	350	150	82.6	77.3	77.6	160 / 50
7	350	150	84.5	79.5	73.5	155 / 65
8	350	150	85.7	76.6	73.6	160 / 50
9	350	150	81.8	77.6	73.9	165 / 55
10	350	150	82.6	77.4	73.4	160 / 55
aPAM 350 gm / t of board						
11	350	150	81.3	78.2	74.9	165 / 65
12	350	150	82.5	76.2	75.8	160 / 60
13	350	150	80.8	77.5	77.7	160 / 55
14	350	150	81.1	75.4	76.5	160 / 55
15	350	150	83.0	77.6	75.8	165 / 60
16	350	150	82.4	78.4	77.6	160 / 50
17	350	150	84.0	78.6	74.8	150 / 65
18	350	150	85.1	77.3	73.6	160 / 55
19	350	150	82.8	78.5	74.4	165 / 55
20	350	150	81.6	78.7	73.6	160 / 55

The application of aPAM in these trials yields an appreciable result in the view of retention, stiffness and rattling sound of board. This is due aPAM has strong flocculating effect when the presence of PAC as compared to all cationic products due to the enriched Al^{3+} content which provide the anchoring sites on cellulose fiber to bond with aPAM retention aid. The reaction mechanism has been below.

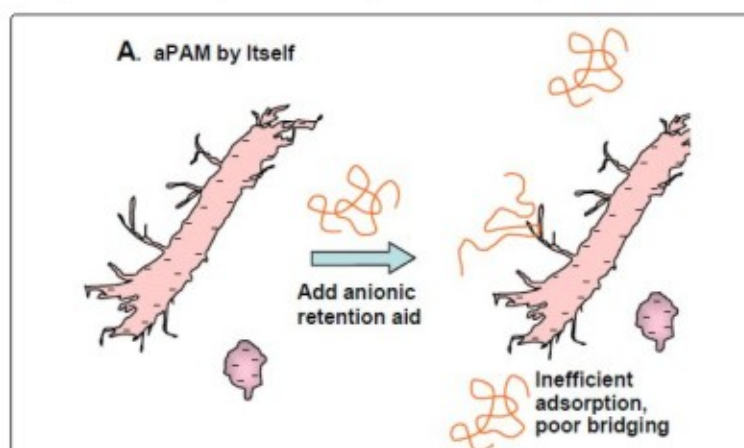


Fig No. 11: aPAM (only) reaction with the negative cellulose

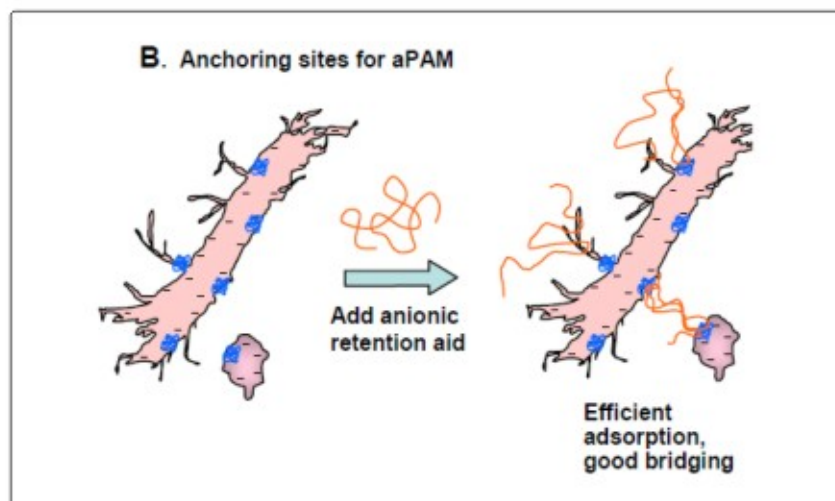


Fig No. 12 : aPAM with PAC (Al^{3+}) reaction with the negative cellulose

Two parameters, almost always critical to good papermaking are paper formation and filler retention. A sheet with good formation has positive impacts on paper strength (6), printability (7) and optical properties, e.g. opacity (8, 9). Formation is a concept which describes the grammage distribution of paper on a scale up to 50 mm (10, 11). The final distribution of fibers in paper materials is principally influenced by two interacting phenomena in the stock; fiber flocculation and shearing conditions. Fibre flocs, defined as local fiber concentration variations, have a negative impact on paper formation. The correlation between fiber flocculation and paper formation has been addressed by several authors depends on both chemical and mechanical factors (12, 13). Before Mason (14), the research claimed that flocculation was mainly governed by chemical factors, based on classical colloidal phenomena. Mason firstly showed that collisions and subsequent mechanical entanglement of fibers were primary factors affecting flocculation of fibers, a concept described as mechanical flocculation. Mason's mechanistic concept laid the foundation for the subsequent research on fiber flocculation. Mechanical flocculation gives rise to fiber networks (flocs), where the fibers are mechanically interlocked in the network if the fiber is in contact with at least three other fibers. Regarding fiber flocculation, the number of contacts per fiber is critical. To quantify the number of contacts, Kerekes and Schell introduced the crowding factor concept (N), where values for N can be calculated from:

$$N = 2C_v (L/d)^{2/3}$$

Where, C_v is the volumetric concentration of fibers,

L is the fiber length,

d is the fiber diameter.

The crowding factor concept combines both fiber geometry and fiber consistency and can be used to characterize the flocculation tendency of a given furnish. When the N -value increases (increased crowding), the probability for fibers to collide increases. Longer fibers, stiffer fibers and an increased consistency will increase the N -value, i.e. the flocculation of fibers. Kerekes and Schell classified fiber suspensions in three regimes (a-c), depending on the crowding factor (a: $N < 1$, dilute; b: $1 < N < 60$, semi-concentrated; c: $N > 60$, concentrated). In commercial papermaking, the range of $1 < N < 60$ is of key importance. From laboratory sedimentation experiments, Martinez et al. concluded that within the range $1 < N < 60$, there were two different sub-regimes present, regarding fiber flocculation. These sub-regimes were delineated at the critical level $N = 16$, where formation was found to be slightly dependent on N in the region $N < 16$ and then worsen significantly with $N > 16$. The machine design and the operational variables should, however, be carefully considered when critical levels for fibre flocculation are discussed. Fibre flocs also affect the behavior and the rheology of the pulp suspension, influencing the fiber network strength. The network strength of fiber suspensions arises from the cohesive forces that act between fibers' at the fibre-fibre contact points. The fiber network strength is one important parameter that influences the paper formation (16).

The fiber network strength is affected by several factors, such as the addition of retention aids or other chemical additives, fiber consistency, fiber dimensions and other factors. One simple method to reduce the network strength and thereby to improve the formation is by reducing the fiber consistency to such a low level that the network strength is negligible. However, this method has a negative influence on the retention, which decreases with decreased fiber consistency. The turbulence, determining the shearing conditions, is essential for fiber flocculation and the subsequent paper formation. Increased turbulence is known to cause a strongly increased reflocculation. Formation aids are, however, effective in order to dampen the turbulence, resulting in improved paper formation (17). Due to shearing of the stock during the dewatering process, fibers and flocs are more evenly distributed, resulting in better paper formation in the sheet being produced. Retention must sustain with the machine operating conditions.

1.1.7. POINTS TO BE CONSIDERED FOR RETENTION

The following points are to be considered as most imperative for better retention in mould operation along with the good retention aid programme.

1. Consistency should be 0.5 to 0.8 % or recommended by mould supplier
2. Cleaning of mould by Booster pump with minimum 15 kg / cm²
3. Periodically cleaning of mould
4. Spray starch should not mixed up with the mould pulp
5. Proper sampling point
6. Addition should be after pressurized screen
7. Faith in lab works

CONCLUSION

While using PAC or alum aPAM gives a better retention , stiffness and rattling sound to the board at cost effective .Proper selection of retention aid is very important for base paper of board making which affects the final board quality such as waviness , board bend low stiffness etc. The weak fiber raw material should be bonded chemically to get a better strength as well as machine runnability. The chemical selection must be based on pulp and paper science not on the basis of credit period. Many mills in India follow the chemical purchase based on the credit period. Supplier must think about all the pulp , paper making technologies has been recommended for foreign countries based on their environment , while recommending the chemical to Indian pulp and paper mills , it is necessary to consider the zero liquid discharge (ZLD), and Indian raw materials , climate, water quality and end use etc rather than profit making.

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