# Dissolve & Colloidal Substances in Agro & Recycled Furnish- Optimization by Bio Engineering

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## ABSTRACT

Profitability is the key for survival in today's Techno economic era of cut throat competition that make the utilization all the resources in its best optimize way imminent. That will not reduce application cost but also prevent the side effect of additional doses.

Variation in waste paper quality & source has become the integral part, and left Paper maker with no choice but to accept whatever has been offered. Agro Furnish reflux which used to be tool earlier days while shortage in one component getting tougher & tougher due to demand of consistency.

We shall cover on the detrimental interfering Dissolve and colloidal substance those who are not only detrimental to the process but also effects the paper properties and process. We shall take the sources of these substance, ways to prevent and if cannot then measures to minimize their impact. They also choke the process in several ways and reduces the efficiency of other additives.

In fact all the additive need an environment of work be it Retention & drainage, OBAs, Dyes, Sizing Chemicals must be used in efficient way, so that has been covered under the discussion in next few slides.

## Introduction

As stated now it is of almost importance to work in hand to hand to break the barriers with efficient technological interface.

It has been found that in general source water quality makes an impact on dose rate or efficiency in several ways. Also in there is emphasis on completely closed system forcing the paper makers to use the same water along with its contamination like turbidity etc. That too affects the other constituents' efficiency in several ways. The paper deals in detail the various environments required for the performance.

If one need to consider one parameter to boost up profitability in prevailing condition it must be drainage. With slight change in drainage the major paper properties changes, it matters for braking length for Fine paper, Tear Factor for Newsprint, Burst factor for Kraft and RCT for sack craft.

There are several detriments interfering substance and their effect has been taken in part one and two different model one based on proper Bio chemistry and second based on the general flocculation chemistry which has been used since decades in our industry.

### Objective

To treat the interfering substance in waste or agro furnish to minimal before optimizing the process for the maximum benefit & healthy .There is requirement of good retention, drainage to enable the process remain healthy. This reduces the requirement and hence contributes directly to cost effectiveness.

## Source of Interfering Substance from Agro/Wood Pulp

1. Wood resins
2. Fatty Acids
3. Triglycerides
4. Styrel Ester
5. Waxes

- Wood resins can be found inside unbroken parenchyma cells in chemical pulp
- Smeared onto tracheids and parenchyma cell surface in patches in mechanical pulp
- Appears as small droplets that are quite stable due to Steric stabilization by Glucomannan
- Inherently not sticky but can turn sticky with circulation, time & destabilization
- Steric stabilization is affected by pH, multivalent ions and temperature
- Peroxide bleaching increases TMP fiber anionic charge by deacetylation of pectin and through lignin oxidation and formation of anionic group in lignin
- The amount of glucomannan released from peroxide bleached pulp is lower resulting in lower stability of wood pitch
- Lesser stabilised wood pitch coagulate better when treated with fixative

## Factors Affecting Drainage

- Fine Fraction of furnish
- Hemi cellulose content of Pulp
- Pulp Freeness of Head Box or mix of different proportion at blend.
- Turbidity of white Water
- Conductivity of the system
- Wire Pattern or % open area

## Requirement of good drainage

If it is quantitative analysis around 98% water is removed at wire section, 1.0% in Press section & 0.8% in dryers. As everyone's is aware that water removal is cheapest in earlier stage as the web passess to pressing section its get costlier and when it comes to Dryer section it is costliest.

Better drainage provides the opportunity to lower the head box consistency hence better sheet formation, in turns several opportunity to play around depending on requirement and need of paper maker in particular situation.

## Tools to Control drainage

- Optimum Jet/Wire speed
- Wire Pattern
- Charge control
- Turbidity & Conductivity
- DRA Programs

It is assumed that once Jet/Wire & Wire pattern has been fixed it is in general it is altered as per speed and head and m/c configuration depending upon the m/c, it need to take care of Z Direction properties. Some paper mills keep it slightly more than 1 to keep the upward properties up. Same is the case with wire pattern which is dictated by furnish.

The major role to control and optimize is turbidity and conductivity, which plays major role in balancing the drainage hence cost effectiveness and productivity. We shall be discussing two models to control the wet end chemistry and nullify the effect of colloidal substances.

## MODELA

### Control of Wet end chemistry with Bio Engineering based on Enzymes.

Enzymes are the best catalyst due to two reasons, First its specificity to react with specified target and second they remains active after the completion of reaction. Enzymes to deal with paper industry generally of Cellulase type.

Cellulases are broadly divided into

**Endoqlucanases (EG)**Which are able to degrade Amorphous cellulose (e.g Carboxy - Methyl-Cellulose or CMC), and

**Cellobiohydrolases (CBH)** also called Exoglucanases, which degrade crystalline cellulose.
Most Cellulaes/Hemi cellulase presents a molecular organization: A catalytic domain and a small cellulose-binding domain (CBD) connected to the catalytic domain by protein cable.

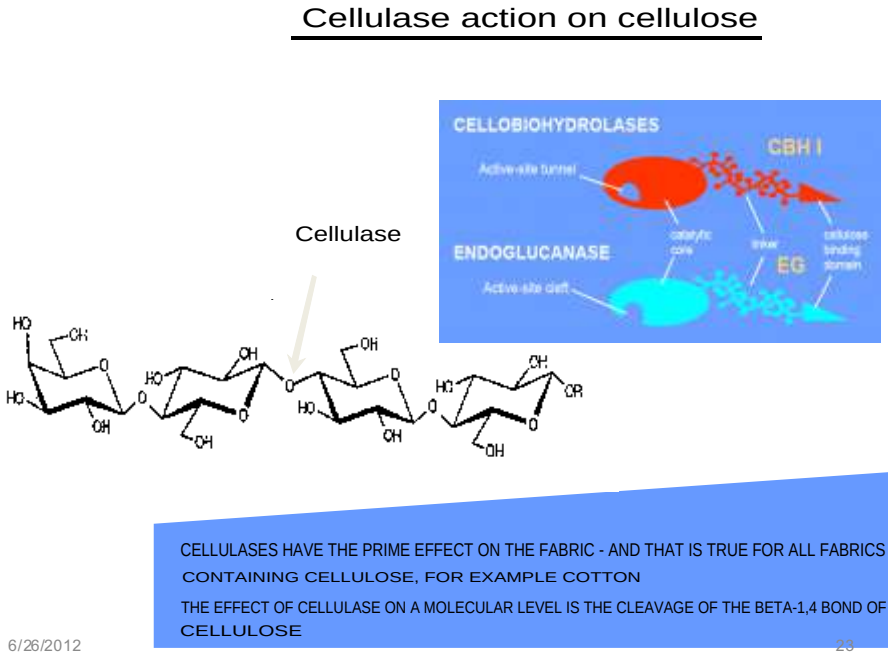
The CBD chooses the region specific to adhere and the catalytic domain performs Hydrolysis. Starting from genetic level, an Enzyme can be designed to attach to specific exposed cellulose/ hemi cellulose chain until breakage of substrate polymer in the point of attachment is attained.

Generally the fibre smaller than 70 µ are termed as fine which passes through the 200 mesh. There are several smaller or in-between size fines disturbs the hydro colloidal system and hinders the drainage they are too small to retain so almost nil contribution to tonnage. These small micro fines are perfect base for the sticky material. Hence removal of these from the system is highly economical.

As discussed above the Endo gluconase hydrolyses these ultra fines to dissolved sugar molecules.

## General conclusion from Bio-Hydrolysis

- Can dramatically reduce energy demand for refining and pulping...
- Often Improve paper strength properties.
- Eliminates micro-fines in white water closed loop.
- Reduce load in dryer section of the paper machine.
- Prevents paper breaks produced by accumulation of fines.



- Reduces use of wet strength additives such as starch, CMC and other Polymers.
- Can Increase paper machine speed.
- Improve paper formation.
- Improve stickest control by favoring contaminant dispersion.

**MODEL B-**

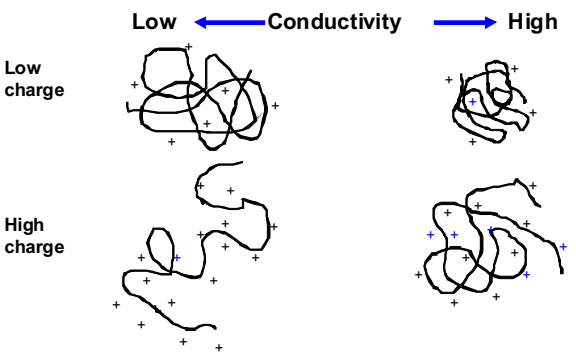
## Optimization with the help of wet end chemistry- Charge neutralization, Flocculation Turbidity & Conductivity

In general all the constituent in Paper making process are anionic in nature be it fibre, fines, Dye , OBA so it is extremely important to balance the zeta potential close to zero thus enable the fibre to prevent from any external force.

The zeta potential adds Surface charge and colloidal charge, the colloidal charge and some disperse material in general contributes to turbidity. Similarly conductivity is other important factor contributes to poor wet end optimization.

**Conductivity** is defined as measure of level of electrolyte ( salt or ions) in a system measured through the electrical conductance means.

### Effects of Conductivity



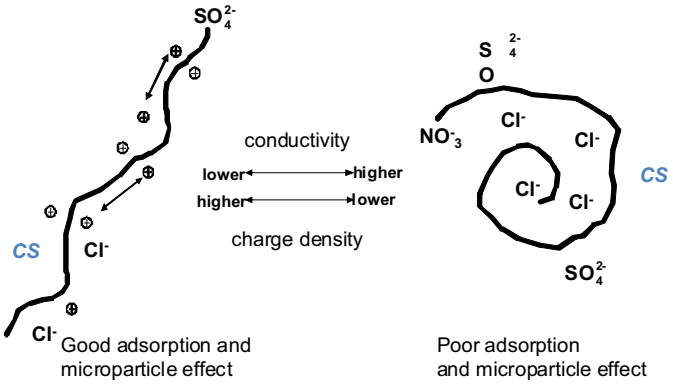

Analytical Tools to estimate impact & Control of the ICS

| Control Parameter | Significance |
|---|---|
| Consitency | Variations in short circulation system have direct impact on paper quality (MD and CD) and measurement tendency |
| Ash content | Variations in the wet end affect paper quality such as strength and porosity- Accordingly, uneven distribution of ash (both MD and CD) generates problems on the paper machine, and in coating and printing. |
| pH | pH affects all chemical reactions at the wet end especially charge level and performance efficiency of additives and chemicals. Sudden changes may cause paper machine runnability problems. |
| Temperature | Considerable temperature variations should be avoided due to their impact on reaction kinetics, deposit formation and drainage. |
| Conductivity | Conductivity is an important measure of the system cleanliness. This parameter indicates the amount of dissolved inorganic material that can potentially form deposits. |
| Drainage and wet strength | Pulp freeness is the most watched quality variable for furnish management. Drainage and wet end strength properties vary with grade, fibre furnish and running conditions thus creating process and quality control challenges to be tackled at the source. |
| Charge | The ability to control the interactions of charged particles, such as fibres, fines and DisCo material is the cornerstone of the wet end stability. |

If system conductivity is very high it does not allow the low charge chemicals branches to open up. It is extremely important in the case of starch. So selection of starch is dictated by conductivity of the system. If it is in the range of 600 to few thousands, higher cationincity starch must be used for better effectiveness.

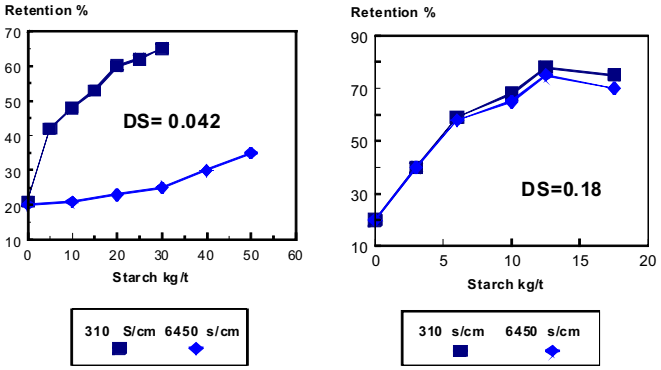
The repulsive force between the charge keeps the branch strength hence provides more contact point so higher efficiency.

### Influence of anionic electrolytes on starch retention




## Effects of conductivity

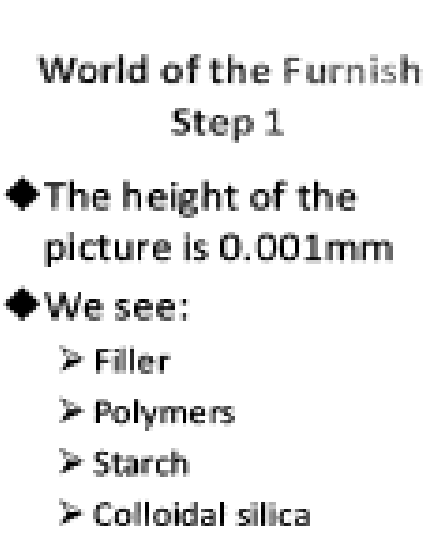
**(0.2 % BMA-9)**

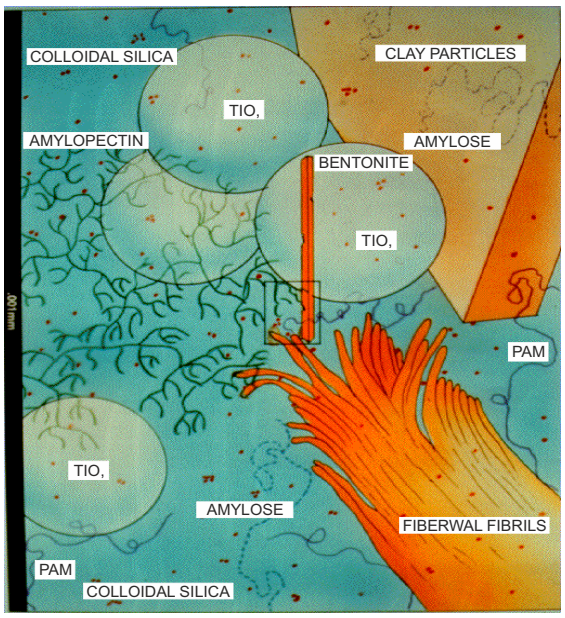


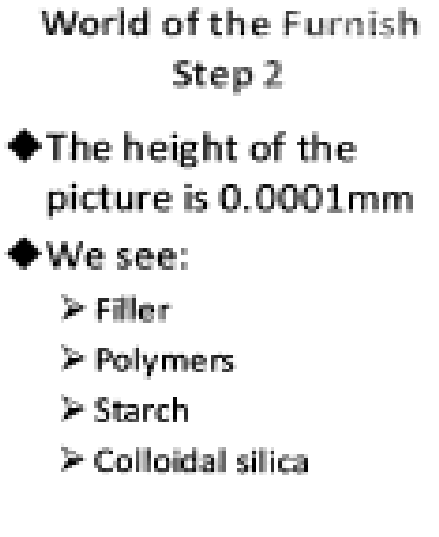

When it comes to waste furnish generally if the tropical conditions are unknown under it was produced just location or source knowledge some time come as great disadvantage. Process conditions like pH and additives play significant role when it comes to reuse the fibre.

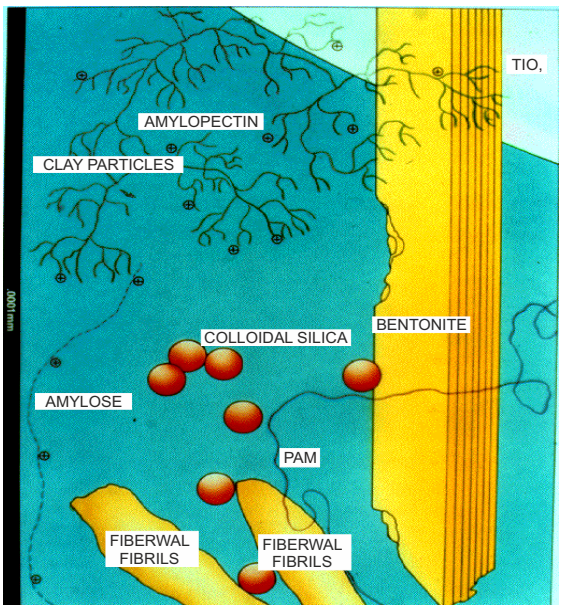
It is advisable to treat the ambience around the fibre to provide it amethyst conditions. So careful study of fibre surrounding is required to balance the Vandarwal forces hence providing fibre an opportunity to align in the required direction without getting effected form the external environment. This issue has been addressed by the charge control to certain extent. But in most of the

| Property | Effects or Interactions |
|---|---|
| Temperature | Correlates with solubility and sorption of DisCo on fibre, high value good for water removal but sensitivity to pitch problems increases. |
| PH | Solubility and sensitivity for pitch problems increases with pH, important parameter for chemical reactions such as bleaching, hydrolysis dissociation of carboxyl groups, surface charge, internal sizing etc. |
| Conductivity | Correlates with the amount of inorganic compounds and ions. Affects the performance of cationic polymers, surface charge and stability of colloids. Increases viscosity of pitch compounds. Affects the hydro dynamical volume of polymers. |
| Hardness | High value increases sensitivity to deposit formations. Affects colloidal stability. |
| Alkalinity | High alkalinity means a good pH stability. |
| Dissolved organic compound | Large amount increases microbiological activity. |
| Turbidity | Measures the performance of filtration processes, correlates with the amount of colloidal particles. |
| Dissolved gases | Large amount of gases causes web quality defects. |
| Surface tension | Low surface tension promotes foaming, important parameter for fibre bonding and water removal. Is affected by the constituents of water. |
| Viscosity | Important for water removal and pitch cohesion. |




cases it has been found that no proper treatment is done to control the colloidal charge which in several cases has been seen affecting the chain structure of which in turn reduces efficiency.

Below picture has been taken to explain the fibre surrounding and has been magnified by 100 0 times. Quite visible the opened up polymer & starch structure in nursing conditions.
Picture has been further modified by 10 times to study its efficacy with filler. Filler structure too found effecting fibre ambience and rhyology around fibre.

The picture below explains the same.

## CASE STUDY & EXPERIMENTS

### MODELA

### Mill trial report (No1)

In the mill, the wet end fines were treated to reduce the turbidity & conductivity was varied constant, its impact on paper properties has been done.

Below case study depicts the effect of Bio treatment in wet end. Clearly the fibre response to the Bio chemistry was encouraging and 30% higher filler to fibre substitution was observed maintaining the same strength, also the wax pick reading were up suggesting the better inter fibre bonding.

### Mill experience 2

In similar other mills on wood furnish once again those results were repeated proving the consistency of the application. Here also mills saved lots of energy and with lower refining requirement and better machine run. Fibre response was great as the below table suggest.

| Parameter | Unit | | Blank | Cellulase | % |
|---|---|---|---|---|---|
| Grade | | | Copier | Copier | |
| Grammage | gsm | | 58.00 | 58.00 | |
| Bulk | cc/gm | | 1.32 | 1.30 | -2.21 |
| Bursting Strength | $Kg/cm^2$ | | 0.93 | 0.90 | -2.86 |
| Burst Factor | | | 16.00 | 15.56 | -2.76 |
| Breaking Length MD | Mt | | 4273.33 | 4029.29 | -5.71 |
| CD | Mt | | 2721.67 | 2862.86 | 5.19 |
| Tear Factor MD | | | 69.20 | 68.83 | -0.53 |
| CD | | | 76.60 | 76.61 | 0.01 |
| Paper Ash | % | | 8.31 | 12.06 | 45.14 |
| Porosity | ml/min | | 750.00 | 630.00 | -16.00 |
| Wax Pick No. Top | | | 8.00 | 9.00 | 12.50 |
| Bottom | | | 7.60 | 8.76 | 15.33 |

| PM- A | | Blank | Cellulase | % Change |
|---|---|---|---|---|
| Parameters | Unit | AMC | AMC | |
| Grade | | 75.00 | 75.00 | |
| Grammage | gsm | 1.35 | 1.37 | 1.11 |
| Bulk | cc/gm | 1.35 | 1.45 | 7.64 |
| Bursting Strength | $Kg/cm^2$ | 18.07 | 19.35 | 7.08 |
| Breaking Length MD | Mt | 5162.50 | 5160.00 | -0.05 |
| CD | Mt | 2877.50 | 3120.00 | 8.43 |
| Tear Factor MD | | 71.29 | 65.50 | -8.12 |
| CD | | 77.86 | 79.50 | 2.11 |
| Paper Ash | % | 8.88 | 11.80 | 32.80 |
| Porosity | ml/min | 800.00 | | |
| Wax Pick No. Top | | 12.25 | 13.00 | 6.12 |
| Bottom | | 11.00 | 12.00 | 9.09 |

## Conclusion

The experiments show one need to identify the detriment sourse in the furnish and treat suitable before applying additives that too must be selected carefully as per process conditions. One has to keep an eye on source of Dissolve & Colloidal substance to get the optimum effect. Also if dealing with the waste apaper the study of conductivity and turbidity must be done before use of any additive which is based on surface tension like Sizing chemicals and other retention & drainage program. Once mechanical constrains are set right these are most influenced factor on paper properties and machine run.

Choice comes to remedy where the Bio engineering can be applied to dissolve the hydro fines. If turbidly & conductivity which has major control on interfering substance are treated to its optimum then proper flocculation or bridging methods can be implemented to get the best wet end stabilization.