Water-Soluble Polymers as Retention Aid in Papermaking

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The papermaking process involves three basic operations. First, a wet web of fibers is formed from a fiber – water slurry and drained on a continuously moving wire. Second, additional water is removed by pressing the web between felts. Third, the web is dried on a series of steam–heated drier drums. The water systems surrounding this basic process will be described in more detail below, as will the complete papermaking system.

Papermakers use water–soluble polymer flocculants in papermaking for two main reasons :

1 To improve retention, within the sheet, of fiber fines, inorganic fillers, and other small particulate matter.

2. To improve liquid–water removal, or drainage, during the papermaking operation.

Historically, improved retention of titanium dioxide in the sheet has been the primary reason for using filler retention aids (1,2). This is because of the high cost of titanium dioxide, compared to other components in the system. The expanding use of other relatively expensive pigments has increased the need for use of a filler retention aid. Also, recent increases in pollution control measures have made the papermaker more interested in improved retention of the cheaper materials such as clay and fiber fines. Papermakers also have become more aware recently of the potention economics in improved retention of fiber fines.

Even through most of the water drained from the wire during papermaking is recirculated to the wire, optimum operating standards require the "first pass" retention to be as high as possible. When inadvertant spills or leaks occur, or when the machine is shut down and drained, the loss of expensive filler and fiber is directly related to the concentration of these materials in the recirculating "white water" (so called because the pigment build–up gives it a white colour). Typical papermaking practice calls for frequent change in the grade of paper being produced. Often a grade of paper which requires a high level of titanimum dioxide is followed by a grade which does not require TiO_2. In such case, the TiO_2 buildup from the first grade will be bled into the second grade until a new equilibrium is built up. In this case the price obtained for the TiO_2 being used in it, so the papermaker would operate at a reduced profit. On the other hand, if the grade without Ti02 was made first, the system would have to be "slugged" with large amounts of Ti02 so that the sheet followihg would conform to specifications This would also cost the papermaker money. Use of a retention aid would minimize Ti02 buildup in the system and avoid these losses.

The use of flocculants to improve drainage, or water removal, in the papermaking process is a relatively new development compared with filler retention. Papermaksrs are primarily interested in drainage aids because they improve machine speeds. Increased machine speed gives increased production for a given amount of equipment which, in turn, makes more money for the papermaker. It is common for a papermaker to get a production increase of ten percent or more. In a typical case, a production increase of ten percent resulted in a net profit increase to the mill of about 3250,000 per year (3).

Increased drainage rates also improve sheet formation and increase sheet strength The improved formation (distribution of fibers throughout the sheet) results from increase dilution of the fiber slurry going to the papermaking process and from removal of excess water by the improved drainage rate. The strength improvement is obtained by increasing the mechanical refining on the fiber itself, which improves strength but decreases drainage. The loss in drainage is compensated for by the increased drainage rate made possible by the polymer. Action of the polymer does not reduce this strength improvement.

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Synergetic Effects of Additives in Efficient Paper Coating

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Indigenously manufactured coated paper and board have an important role to play to meet the growing demand of these products. Efforts are required to be made continuously to improve the coationg colour, process of coating, equipments, timely evaluation, etc., to improve overall efficiency of paper coating. The pigments and binders have of course specific role to play in paper coating but other additives e.g, defoamers, antifoamers, lubricants, wax emulsions, preservatives, flow modlfier and insolubilizers, etc. have their own role to play to improve the efficiency of paper coating.

The present paper deals with a few above mentioned additives, their functions, characteristics and the synergetic effects of their addition on coating colour, process and properties of coated paper and board It has been concluded that though the requirement, in general, of these additives is very small but these have become fundamental ingradient of coating colour, hence we have to regularly upgrade our formulation, with growing technological advancement, to achieve efficient working and optimum results.

The demand of coated paper in India has increased significantly in the recent years. It is also anticipated that with the keen competition in the various areas e g. packaging, printing, etc., where coated paper and boards are used, demand of coated paper and paper boards will further increase. Hence, it has become potential area for the paper industry to give due importance to upgrade the technology of coating for improved productivity with better efficiency.

With the continuous improvement of technology in the area of machinery and equipments used for coating, introduction of improved grades of pigments and binder at the same time fast upgradation of printing technology, it has become essential to review and upgrade the overall process, presently being used, to meet the requirement of market.

The pigments and binders have specific roie to play in pgper coating but other chemicals called additive e.g. dispersant, difoamers, preservatives, lubricants, etc. have also important role to play in adoption of new technologies at the same time improvlng overall efficiency of paper coating. For specific use of these it is very much necessary to understand their functions, characteristics, synergetic effect of additives when used in various combinations, etc on paper coating process to use them in appropriate manner and efficiently.

ADDITIVES :

The paper coahting additive may be defined as substances which are added to the wet coating composition to enhance, optimize or improve the coating layer properties or to remove operating problems during mixing, coating drying, calendering and finishing process. All other materials in a coating formulation excluding pigment, binder, colourants and vehicle can be broadly classified as additives These are used to regulate operating performance and ultimately yielding better final coated paper and paper board The selection of additive depends on its specific or multiple functions, The details of some of the additives are as follows :

DISPERSANT :

The basic requirement of coating colour is that it should be homogenous and more fluid for getting better results. Most pigment particle when made into water slurry are attracted for one another and resist flow. The dispersants are the chemicals which on addition in small quantity counteracts this effect and makes the coating colour more uniform and fluid They are broadly classified as polyphosphntes, alkali silicates, alkalis, ionic and non-ionic polymeric dispersant.

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At the time of pigment slurry preparation mechanical disaggregation, dispersion and finally deflocculation take place. Most of the dispersant imparts electrical repulsive forces to individual pigment particles to counteract normal attractive forces which would cause reaggregation in the finished coating. The repulsive forces of dispersion may be in the form of electrical charges of adsorbed ions furnished by the disociated dispersing agent or as a film barrier of a protective colloid.

The selection of dispersant and quantity in coating colour preparation will depend on the pigment used, infrastructure available for mixing, casting and drying methods Effect of time and temperature of coating colour on the performance of dispersant should also be examined before its content use in a given system.

FLOW MODIFIERS :

This class of additives are important particularly to to control, lower and stabilize the viscosity of binders and in turn overall viscosity and flow droperties of coating colour. Urea, dicyandiamide, sodium seqisilicates, water soluble polymers etc, Some additives e g. alaginate, CMC, etc are used sometimes to increase viscosity, However, depending on the need of system selection is done.

These additives give wider option to coating formulators for selection of different ingredients of coating colour at the same time giving higher productivity too. For example, with the use of these additives, high total solid of colour with low viscocity can be run with higher speeds of machine without any change in the process conditions and hence improving productiviiy of the system. Efficient use of starch and casein as binder can only be done with the use of flow modifier, since both of these binders have tendency to increase the overall viscosity of coating colour.

FOAM CONTROL AGENTS :

Entrained air in a paper coating significantly increases the viscosity of coating system and also causes surface imperfections in coated paper. Adverse effect on surface properties are due to rupturing of foam during the coated paper dries up. The entrained air in the coating colour is more difficult to detect, or to isolate and remove compared to conventional foam on surface.

Most of the ingredients used to prepare coating colour encourage stable air entrainment. Though, lot of work has been in the advancement of handling system, coating colour preparation systems etc still chemical additives are required to overcome this problem. Most of these additives are classified into two categories one which prevents stable air dispersion known as 'antifoamers' and second which remove the air already present in the slurry known as 'defoamers'. Some of the foam control agents are pine oil silicon emulsions, higher alcohols, etc. The requirement of coating formulater is nonfoaming system and efforts are needed to incorporate foam control agents in the natural and synthetic binders.

The use of foam control agents can not be confined to their effect on air bubble, Many side effects such as adverse effect on solubility, rheology, water receptivity of the surface, coating penetration, etc. which may ultimately adversely effect the overall efficiency of system. Hence, proper selection and use should be done while using toese additives to achieve optimum results.

INSOLUBILIZER :

One of the requirements of coating is to be resistant to water The adhesives i.e protien, starch and synthetic adhesives vary in their inherent ability to resist water damage Insolubilizers reduce the water solubility or sensivity of the pigment binders used in coating colour so that dry pick and wet pick improvements, dry rub and wet rub improvements and water resistant properties are developed.

In some systems, the insolubilizer is heat-activated during tbe drying process, in some coating formulations it is a question of time and temperature and in others the solution containing the insolubilizers is applied to the surface of the coated web where it reacts with the adhesives in the system Formaldehyde, Zinc sulfate, etc. for protien and casein, urea formaldehyde and malamine formaldehyde resins, glyoxal, etc for starch and U F. resins and M F. resins for latex are effective insolubilizers.

PRESERVATIVES :

In coating colour containing binders, stabilizers, etc. supply basic elements such as nitrogen and carbon which are required by living organisms for their life and reproduction. Recirculation, aeration and ideal

incubation temperatures provide ideal environment to encourage proliferation of backteria and fungi. Microorganisms attack on adhesive, can change viscosity, flow properties and bonding strength. It can also cause change in pH, discolouration, malodour and operational problems. This may ultimately result in lower efficiency and productivity.

Preventive steps are required to combat this problem because once started, the effect of microorganism damage is irreversible. To minimize this damage, good house-keeping, periodic sterilization and good equipment design aid are required. The chemicals used for this purpose are organo sulphur, phenolics organo halogen, amines, etc.

The choice of the suitable chemical depends on the type of bacteria or fungus developed in a particular type of coating and also other conditions like temperature, pH, time of storage, etc.. The choice of chemical will also depends on the end use of end product. In case coated paper is used for food packaging very toxic preservatives can not be used.

LUBRICANTS :

During the coating operation lubricating of wet coating can improve flow properties. There is a definite degree of overlapping in the action of flow modifier and lubricants as they affect the wet coating mix. The main functions of lubricants are to impart lubricity and plasticity to the wet solution and to create smoothness and gloss development during calendering operation. Lubrication of dry coating during calendering, cutting, trimming can affect overall properties including smoothness, printability, reduction in dusting and cracking, etc.

Most of the coating lubricants belong to one of these groups e.g. soaps, sufonated oil, esters, wax emulsions, etc. Soluble and insoluble soaps are able to lubricate wet coating. Sodium and amonium sterate promote uniform wetting of application and distribution of coating. They also assist to lubricate dry coating to improve coated paper properties. Emulsions are used for high finish calendering.

OTHER ADDITIVES :

Apart from the main classes of additives discussed above, there are a number of other additives available which are being used to improve overall efficiency of coating. Antistatic additives are used to ease operating problems of conventional paper and represents a method to obtain conductivity on electrophotographic papers. Optical whitening agents and special dyes are used to have the improved surface properties. Use of certain surfactant in coating colour enhances the dehydration rate of emulsion adhesives

The above mentioned additives have the varying field of application at the same time they have to perform alone or in combination with other chemicals vital functions which would have direct impact on overall efficiency of process of coating. These are added in a very insignificant quantity but often they become very essential part in construction of formula of coating colour and ultimate product quality. Some of the additives have got special role to play to solve the operating problems, to increase the flexibility of process and most of the time improving overall efficiency of the process. It is noticed that addition of some of the additives change significantly the overall performance of process and product.

A few typical formulations of additives are given below :

1. Dispersant—

	China Clay	Titanium Dioxide	Calcium Carbonate
Polyphosphate	0.5%	0.5%	—
Polyacrylate	—	—	0.3%

2. Flow modifier—

	Protien	Starch	Synthetic binder
Urea	5.0% on binder	10.0% on starch	Nil.

3. Insolubilizer—
   - Melamine formaldehyde : 10% on binder
   - Urea formaldehyde : 12% on binder
   - Glyoxal : 15% on binder
4. Preservative– 0.5% on total solids in coating colour
5. Lubricent – 1.0% on total solid
6. Form control agent –
   - 0.2% in pigment slurry
   - 0.1% in bineer prepartion
   - 0.2% when foam develops
7. Other additives –
   - Depending on the requirement of end product quality.

A few formulations are given above. However, use of different additives will depend on overall process variables including ingredients of coating colour, machinery and equipment, flexibility of process available and also the properties required in coated paper. The quantity of additive, in a formulation, will depend upon its quality and effiiciency to perform the job for which it is used. It may be observed that most of the additives can not be easily identified/analysed chemically and as such they are available with trade names only. A modified basic chemical or a combination of chemicals as normally used for preparation of particular additive to work efficiently and such chemicals are given trade names. The efficacy of individual additive is to be evaluated separately to reach to a conclusion about its use In the process. The following are some of the areas where use of additive show the direct improvemant in overall productively of the process :

1. Use of appropriate disperent in correct doses gives homogenous slurry with minimum viscosity. This results in uniform coating application, least operational problems and better and uniform gloss of coated paper.

2. Use of urea and or dicyandiamide results in reduction in viscosity with protien or starch as binder. This allows coating technologist to work at high solid in colur which in turn results in less energy requirement for drying with higher production.

3. Entrained air in coating mix gives high viscosity, operational problems and surface defects on the final product ultimately affecting quality of products. Addition of 0.3 to 0.5% antifoamer and/or defoamer overcome this problem and ultimately give rise to good quality with uniform surface.

4. Addition of 0.5 to 1.0% of calcium or ammonium sterate improves the smoothness and finish of the product as well as improves the dry wax pick.

5. In absence of sole synthetic binder and availability of only costly and inconsistent quality of casein, the use of U. F. and M. F. resins have opened a new area for coating formulation using starch as binder Use of starch will have significant impact in lowering cost of production without any adverse affect on quality of production.

6. Use of preservative results in minimum wastage due to spoilage of coating mix and also have minimum operational problems and with improvement in product quality.

7. Other special additives has direct impact on cost of product for achieving special properties when they are used.

CONCLUSION

IT CAN BE CONCLUDED THAT need of additives is to overcome operational problems, more flexibility of the process, improve quality of the product and over all improvement in the productivity of the process. Though, the requirements of these additives, in general, are small compared to other ingradient of coating colour but have definite impact on process. It is suggested to coating formulators to regularly upgrade the formulation, with growing technological advancement, to achieve efficient working and optimum results.

REFERENCES

1. Busih, T. H., Tappi Vol. 49, No. 6, 154 A (1966).

2. Macdonald, R. G., Pulp & Paper Manufacture, Vol. II, McGraw Hill Book Co., N.Y. (1969).

3. Pai, P. A., etal, Ippta, Vol. 21, No. 4, p. 1 (1984).

4. Rohman, M. E., Tappi, Vol. 57, No. 5, p 96 (1974).

5. Casey J. P., Pulp & Paper IV, W. I. Publication, N. Y. (1983).

6. Lepoutee, P. Tappis, Vol. 68, No. 3, p. 114 (1985).

7. Mosoer, R. H., Industrial Speciality Papers, Vol, 1, Chemical Pub. Co., N Y. (1968).

8. Lafuye, J. F., etal, Tappi Jr., Vo. 70, No. 8, p. 43 (1987).

9. Tappi Coating Conference Preprint 1967, Tappi Press, Atlanta (1976).

10. Casey, J. P., Tappi Jr., Vol. 67, No. 5, p. 127 (1984).

11. MC Alpine, I, Paper Tech. & Ind., Vol. 26, No. 4, p. 194 (1985).

12. Hagemeyer, R. W., Pulp & Paper Canada, Vol. 87, No. 12, p. T 450 (1986).