Study on the effect of different processes and papermaking inputs on Dispersed Rosin-PAC sizing system at neutral pH

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Paper sizing with Rosin- PAC/ Alum is a well-established system and is in practice for a long time but there are still certain parameters which affect the sizing process and are specific to individual mill conditions. The objective is to achieve efficient sizing without any significant interference with other process as it also influences the subsequent operations at the customers end. In this paper, our experience with dispersed rosin- PAC system and its interaction with other chemicals and process is discussed. To get the maximum sizing efficiency with optimum usages of sizing material and other inputs the parameters such as Stock pH profile; First Pass Retention, sequence of addition of chemicals etc are to be maintained within a given range the along with the quality of sizing material. Along with these parameters, effect of other chemicals such as defoamer and processes such as paper machine back water recycling which increases calcium build up, conductivity, electrolyte concentration needs to be controlled at a desirable level. The interaction of different processes and paper making inputs, which lead to a vicious circle resulting in problems like foaming at paper machine wire, reduction in paper machine back water recycling due to increased conductivity are evaluated on the basis of our experiences in the mills. The mill has implemented cost effective remedial solutions to avoid these problems in order to improve machine runnability while maintaining quality of final product.

INTRODUCTION

Internal sizing of paper started long back in 1800 but the real development in Rosin- Alum sizing system came into picture in 1950's. After that, different sizing methods have been adopted to size the paper. Reasons due to which paper making systems have shifted from acid to neutral and now to alkaline conditions have been reported in literature.

Conventional rosin soap- alum sizing system has shifted to dispersed rosin size alum/PAC system for developing sizing around neutral conditions in many mills in India to get quality and cost advantages as well as other benefits like controlled back water TDS build up and higher degree of water recycling.

Various performance-enhancing chemicals such as cationic polymers like polyamines, polycrylamide are introduced which acts as a mordent/ retention aid for neutral dispersed rosin size to enhance functional performance. But along with these benefits, there are certain problems with rosin-PAC system like foaming tendency at paper machine wire at neutral pH, which creates runnability and quality problems. These problems may be due to poor quality of sizing chemical or in-compatible process and other inputs used for different purposes.

Increased recycling of machine backwater leads to build up of TDS (Total dissolved solids), conductivity and EDTA hardness in the system. These buildups after certain level forms species having no sizing value but creates foaming problem in paper making system. These conditions may require use of suitable defoamer and optimization of process conditions, correct point of addition and dosage of various inputs.

The purpose of this study is to optimize the neutral dispersed rosin size alum/ PAC system along with other chemicals like defoamer and paper machine back

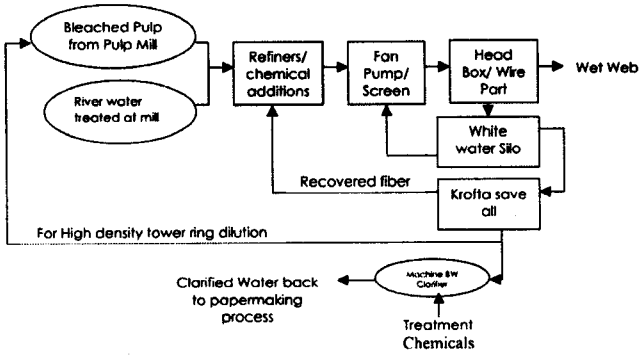


Figure 1: Paper Making Process

water recycling treatment to manufacture of paper at minimal resources and cost without compromise with quality.

Mills experiences with Dispersed Rosin PAC sizing system

Mill is using dispersed rosin-PAC sizing system successfully from last 9 years with talc as filler. This system was also used in the past about 3 years with ground calcium carbonate (GCC). But in the recent past, mill has experienced some issues with system due to incompatibity of different processes as well as input chemicals.

During papermaking with dispersed rosin sizing system, all parts of the paper manufacturing have to perform its function suitably along with other auxiliary chemicals. During the process, vicious circle with regard to functioning of different chemicals was observed leading to machine runnability issue, quality related problems, higher chemical consumption and wastage of resources.

This circle defined in Fig-2 explains how the performance of one chemical affects the performance of other chemicals. The mill was facing serious problem of foaming at paper machine wire resulting in quality issues as well as affecting consumption pattern of rosin and PAC and paper machine back water recyclability. To find out the root cause of the problem, it was observed that foaming at machine wire could be tackled by reducing machine backwater recycling and use of fresh water. However, with this remedy, the system was stable at a backwater pH of 5.6-6.0, which was much lower than the target. As soon as pH of backwater increases to 6.8 foaming problem gets aggravated. There is a dedicated clarifier for excess machine backwater. But higher use of fresh water with more purging of machine backwater is neither desirable nor acceptable to management due to fresh water conservation issue.

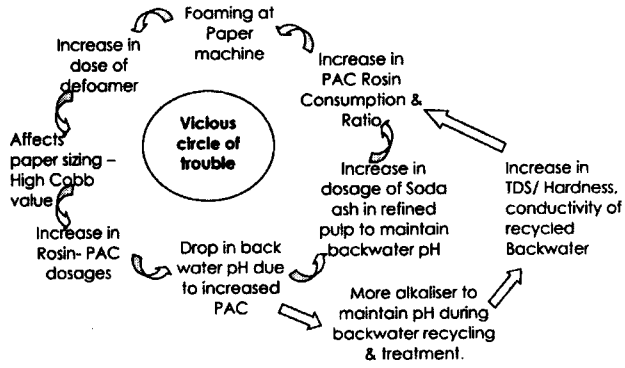


Figure 2:

The process was then optimized on following points to overcome the trouble.

1. Optimization of pH profile for optimal performance of sizing system
2. Defoamer quality at paper machine
3. Performance of dispersed rosin sizing at neutral pH.

Table 1: Laboratory analysis of Rosin & PAC System

Stock pH before addition of Dispersed Rosin	Back water pH	Dispersed Rosin, Kg/T	PAC, Kg/T	Cobb, 60	Rosin: PAC Ratio
	6.8	25	25	35.3/38.3	1:1
8.0	6.8	25	30	30.3/30.6	1:1.2
	6.8	25	35	24.0/28.2	1:1.4
	6.8	25	25	22.9/23.3	1:1
6.8	6.8	25	27.5	21.9/22.1	1:1.1
6.1	6.8	25	25	20.1/21.3	1:1

Study-I(A): Bench scale study on pH profile of system:

pH profile of the system basically depends on the amount of alum/PAC added to the system for optimal sizing. The amount of PAC/ alum required depends on amount of size used, character of the stock, pH water quality etc. Best utilization of rosin size & PAC requires appropriate pH control. This was studied by bench scale evaluation to fix the pH profile of the system.

Experimental details:

As the performance evaluation of defoamer in laboratory has its own limitations, the parameters affecting the performance of dispersed Rosin- PAC system were evaluated in bench scale study.

The variables selected for bechscale study were:

(i) Dispersed rosin- PAC ratio

(ii) Different pH level of Stock before addition of dispersed rosin

Hand sheets made on British hand sheet mould with our standard paper making process were evaluated for development of sizing in paper by measuring Cobb-60 method. The details are given in Table-I

OBSERVATIONS

- Rosin and PAC consumption can be controlled at lower level by keeping stock pH about 7.0 before addition of dispersed rosin. But when PAC in the system reduces, there has to be good retention aid program for retention of fines and dispersed rosin-aluminum aggregate.

- If dispersed rosin is added in stock at a pH above 7.0, the consumption of rosin & PAC increases and rosin: PAC ratio gets disturbed significantly which has its own consequences like drop in back water pH, requirement of more alkaliser to maintain desired pH of recycled water etc.

This evaluation and observation gave direction to apply the concept at paper machine.

Study-I (B): Application of Bench scale evaluation at paper machine

Bench scale evaluation was carried out in British hand sheet mould without any recirculation of back water and shear. Therefore the consumption levels in laboratory were on higher side compared to plant scale application. However with proper pH profile at paper machine, there was significant reduction in size chemical consumption. It also helped momentarily to control foam at machine wire as indicated by reduction in defoamer consumption.

The dosing points of chemicals are given below

Soda ash	: In refined pulp
Dye/ OBA	: Refined pulp after soda ash
Rosin/ PAC	: After Dyes & OBA at Machine chest.
Retention aid	: After centricleaners

Although in new system, pH of the refined pulp was brought down from 7.8-8.0 to 6.7-6.9, pH at the SR box and head box stock was maintained at the same level. This is because of the fact that dispersed rosin and PAC consumption as well as PAC: dispersed Rosin ratio reduced significantly. This has helped to solve the problem of foaming at machine wire to some extent without changing the defoamer quality.

Implementation of this action helped to reduce the frequency of purging machine backwater, which was essential earlier to avoid foam trouble at machine wire. But even after this, issue of foam at machine wire was not eliminated completely.

Although pH is an important factor in sizing process but there is no fixed value for all systems due to differences in stock quality, pH of pulp, anionic trash, use of additives/ chemicals other than sizing chemicals,

The pH profile before and after implementation of idea:

	Unrefined pulp	Refined pulp	SR Box	Head Box
Previous pH Profile	6.0-6.2	7.8-8.0	5.0-5.2	5.8-6.0
Modified pH Profile	6.0-6.2	6.7-6.9	4.9-5.1	5.8-6.0

Table 2 : Chemical consumption after adjusting pH Profile

Particulars	Dispersed Rosin, Kg/T	PAC, Kg/T	Rosin: PAC Ratio	Oil based defoamer, Kg/T
Previous pH Profile	15.0	19.6	1:3	2.0
Modified pH Profile	14.0	14.0	1:1	1.5

Table 3 : Sizing chemical consumption with water based defoamer

Particulars	Dispersed Rosin, Kg/T	PAC, Kg/T	Rosin: PAC Ratio	Defoamer, Kg/T
Oil based defoamer	14.0	14.0	1:1	1.5
Water based defoamer	12.5	12.5	1:1	0.85
PH profile after implementation of this idea				
	Unrefined pulp	Refined pulp	SR Box	Head Box
Previous pH Profile	6.0-6.2	6.7-6.9	4.9-5.1	5.8-6.0
Modified pH Profile	6.0-6.2	6.7-6.9	5.2-5.5	6.6-6.8

water quality, degree of closure etc. The pH profile for optimum sizing depends on several factors and varies from one machine to another and one mill to another mill. Laboratory experimentation under mill conditions are helpful in optimizing process conditions with guide lines on dosages and addition points.

Study- II: Effect of defoamer on Sizing Performance

Although the consumption of dispersed rosin & PAC reduced substantially and the conditions were maintained to avoid foaming, foaming problem could not be eliminated completely. Following other options were considered:

- Entrapment of air in the system
- Evaluation of the performance of in-use oil based defoamer by changing over to other defoamers available in the market.

The reasons for air entrapment were eliminated by systematic study of the system. The frequency of foaming was periodic in nature and it was solved successfully by purging backwater and make up with fresh water so as to maintain a balance and achieve equilibrium.

It was then decided to change over from oil-based defoamer to water-based defoamer. However, it is well known that any surface-active agent affects the sizing performance. Addition of small quantity of defoamer is beneficial to the sizing process due to improvement in sheet formation due to de-aeration of stock but excess defoamer added to system is detrimental to the sizing system performance.

The consumption level of oil-based defoamer was as high as 2-3 kg/T of paper to control foam at machine wire, which was a cause of concern. When oil-based defoamer was changed over to water-based defoamer, the foaming trouble reduced drastically and the dispersed rosin size consumption came down to achieve a target Cobb value at a higher backwater pH of 6.8.

Details of consumption of different inputs are given in Table-2.

Study-III: Effect of Quality of dispersed rosin size

With study-I and II, dispersed rosin size consumption and issue of foam was brought under control. The following two factors were also studied for foam problem and rejection on account of quality.

- Quality of dispersed rosin size emulsion
- Quality of recycled water due to more recycling in

Table 4 : Chemical consumption with different quality of sizing material

Particulars	Dispersed	PAC, Rosin, Kg/T	Rosin: PAC Kg/T	Defoamer, Kg/T Ratio
Dispersed Rosin Size-I	12.5	12.5	1:1	0.85
Dispersed Rosin Size-II	9.5	9.0	1:0.95	0.5
PH profile after implementation of this idea				
	Unrefined pulp	Refined pulp	SR Box	Head Box
Previous pH Profile	6.0-6.2	6.7-6.9	5.2-5.5	6.6-6.8
Modified pH Profile	6.0-6.2	6.7-6.9	5.2-5.5	6.6-6.8

the system.

Most of the mills are outsourcing rosin size emulsions. The quality of rosin size dispersion is somewhat secretive and depends upon the way supplier achieve the dispersion. The composition and components of the emulsion are not normally known. The quality of rosin emulsion in the laboratory is checked for the performance parameters with certain characteristics, which are related to purity such as acid no, saponification value etc.

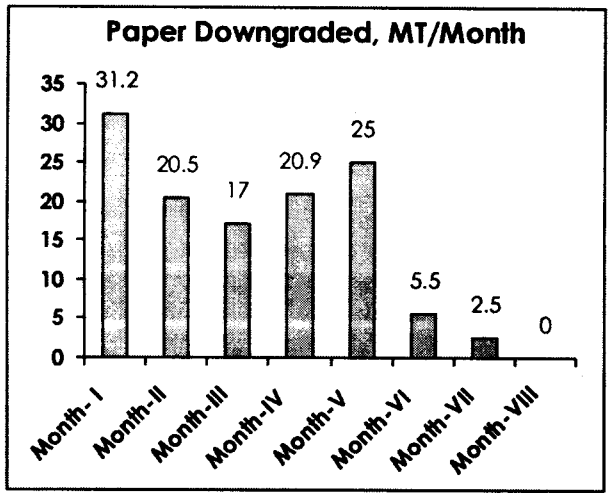
It is not feasible to evaluate all the inputs for related effects such as foam generation, interaction of different inputs in such a routine laboratory evaluation. These side effects need to be evaluated and analyzed during manufacturing process on the basis of plant trials.

By changing over to better quality sizing materials, through a systematic laboratory study and plant trials, mill has eliminated most of the problems at same cost of chemicals due to significant reduction in consumption of dispersed rosin emulsion, PAC and defoamer. Table-IV shows the results.

This consumption pattern of dispersed rosin size & PAC has been found optimum particularly when the temperature of the system is high.

Benefits of optimization of total sizing system with dispersed rosin and PAC

- Foaming trouble was eliminated completely, which has resulted in almost zero rejection of final product on account of foam spots. (Figure-3)



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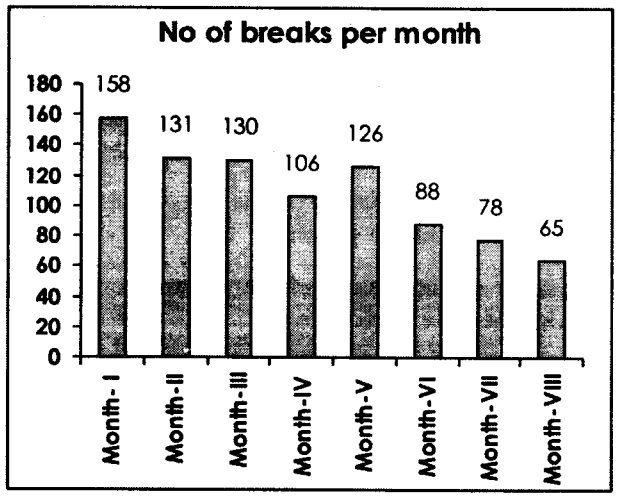

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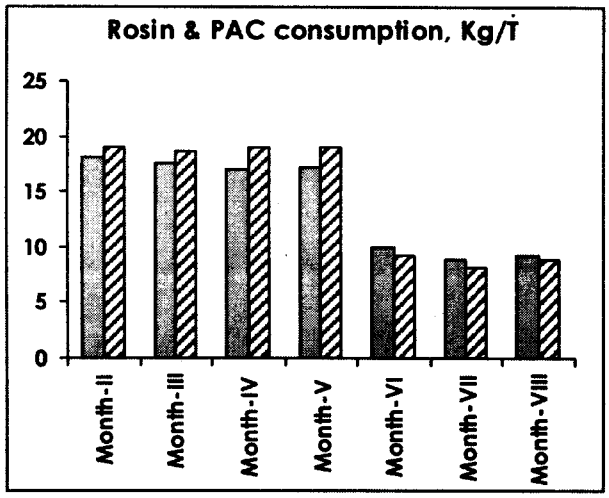

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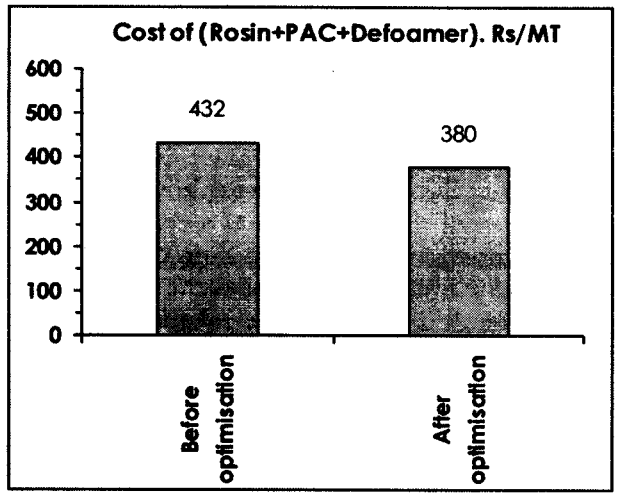

Figure 6:

• Use of good quality water based defoamer resulted into foam free and cleaner wet end system with less accumulation of deposits of fines in back water systems. It has reduced breaks at paper machine due to elimination of non- slime lumps from the system. (Figure-4) It has reduced the boil out frequency, which resulted into reduction in boil out chemical cost by about 50-55%. The overall runnability of machine improved with improved quality and consistent product.

• Reduction in consumption of dispersed rosin size and poly aluminum chloride by about 45-50%. (Figure-5)

• The reduction in PAC consumption helped to reduce the conductivity, TDS, chloride and calcium buildup in back water system resulting in more recycling of paper machine backwater (higher degree of closure).

Effect & Possible remedies for other parameters affecting sizing process

Although system has been optimized for improved process of paper manufacturing, sizing process is also prone to following problems particularly in summer season.

• Temperature of the system.

• Build up of TDS, calcium hardness and conductivity in the system due to recycling.

These two factors make it difficult to operate sizing process at optimum conditions in summer season.

With increase in the ambient temperature particularly in summer season, at same degree of water recycling, temperature of the machine backwater goes up to 42-43°C. At this temperature, the performance of dispersed rosin-PAC system gets affected due to reduction in charge density of aluminum species.

These factors increase the rosin and PAC consumption. The magnitude of problem increases with increased degree of closure and the trouble starts. Although unlike rosin soap size, dispersed rosin emulsion is less susceptible to the calcium hardness in water at lower level, dispersed rosin size also at a concentration of above 500 ppm starts forming calcium rosinate, which has no sizing value but increases the size chemical consumption. It is worthwhile to take following steps to improve water-recycling system.

1. Conventional method of water clarification is use of alum/PAC as a coagulant alum/ PAC system. Alum/ PAC is acidic in nature and reduces pH of the system. To bring back pH to original level, addition of costly sodium compound is required in place of cheaper calcium based alkaliser to keep the calcium hardness build up under control. But it does not take care of build up of conductivity.

In such conditions use of synthetic flocculant/coagulant or clarification of krofta treated water will help to reduce build up of hardness, TDS and conductivity.

2. As paper machine back water contains lot of nutrients and significant BOD, conventionally the water is treated with chlorine based chemicals to maintain the desired level of chlorine in back water to avoid biological growth. It is important to avoid use of chemicals such as calcium hypochlorite, which may contribute to build up of calcium hardness and conductivity.

3. The use of cold soda process is another option to remove the excess calcium hardness above threshold limit, but it is to be considered after implementation of other methods.

4. Use of synthetic sizing agents at size press, which reduces wet end rosin size PAC requirement helps to keep the conductivity of backwater at lower levels.

CONCLUSION

Although paper sizing with Rosin- PAC/ Alum is a well-established system, there are many inter related parameters specific to a given mill conditions, which affect the sizing performance. These parameters need a careful study both in laboratory and plant to optimize sizing performance with minimum cost. It will be beneficial to discuss the problems with the supplier who may supply the tailor made products for a given machine.

To get enhanced sizing performance without interference with other process is the main objective. Parameters such as stock pH profile, first pass retention, sequence of addition points of different chemicals etc are to be maintained along with the use of proper sizing material. Besides effect of other chemicals such as defoamer and processes such as paper machine backwater recycling which increases calcium build up, conductivity, electrolyte concentration needs to be maintained at the desirable level.

Optimization of these chemicals and processes help to avoid issues like foaming at paper machine wire, reduction in paper machine backwater recycling due to increased conductivity etc in a cost effective manner.

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