Scientific Approach of Water Management and Conservation

K.S., Rajesh, M.C., Faizur Rahman, Mohammed Naseeruddin, Ranjit N., Marappan S., Elangovan S., Mani., R., Krishnan, R.V., Venkoba Rao G.

Water Conservation Team, Tamil Nadu Newsprint and Papers Limited, Kagithapuram 639 136 (T.N.)

Abstract

Efforts taken in Tamil Nadu Newsprint and Papers Limited (TNPL), to manage reduced water availability situation by resorting to a scientific approach of water conservation schemes through rerouting and recycling, paved way to keep the mill running during water crisis. Being an environmentally responsible company, efforts are always on to keep on reducing the specific water consumption through modifications and technology upgradation. The paper discusses our experiences in conserving water; both positive as well as negative during water shortage and during normal water availability situations. The ways and means of reducing water consumption has been discussed. More than the efforts of the water conservation team the whole hearted involvement of the management and the mill personnel was the key to our success.

INTRODUCTION

Water has become a precious commodity. A scientific management of water usage is warranted not only to save the resource but also to reduce the wastage of input chemicals. Improvements in pulping and paper technology have been focussing on ways of reducing the specific water consumption. With dwindling water resource availability, the mills now have to wake up, to cope the situation since water is the major raw material for papermaking.

Water reuse and recycling has become increasingly important. Opportunities to save steam and reduce fresh water requirements caused some companies to look more closely at water reuse. The requirement for pollution abatement, such as "Zero Discharge" increased the interest in this subject. Rising cost of energy fuels ensured the wide spread implementation of water reuse on economic grounds.

The driving forces for reducing fresh water consumption are :

Legislation and permission in respect to either fresh water consumption or effluent discharge.

Cost

Fresh water and its treatment

Effluent treatment and possibly effluent discharge cost

Material savings: Fibres fines and filler

Energy savings

Fresh water availability

New paper mills are designed to minimize the amount of effluent water generated and some mills have achieved zero water emission. "Kidney" technology reduces the effluents in the circulation water while recycling pigments and fibres.

The pulp and paper industry is in a much better situation with respect to environmental issues than it was 30 years ago, when pollution was obvious. Now, mill effluent emissions to the surroundings are relatively minor and are tightly controlled by authorities and the industry itself. The fresh water consumption in Europe averages to 40 m^3/tonne of product. It was 100 m^3/tonne 25 years ago (1).

Advancement in technologies has greatly reduced the specific water requirement in the processes. However, in mills running with older technologies, there is an urgent need to look into options for reducing the specific water consumption through recycling, back water reuse, fresh water replacements etc. The paper deals at length, the efforts taken in TNPL, to reduce specific water consumption and steps taken during water availability crisis.

The objectives of water conservation and reuse in TNPL

To identify points of fresh water usage.

To identify areas where excess process back water is available and its quality.

To identify suitable points where this back water could be used without affecting operation.

The measures were started with the aim of reaching a specific water consumption level of 85 m^3/tonne as a first step and 65 m^3/tonne as a second step from the earlier level of 100 m3/ tonne. This paper gives the theoretical background of the steps taken and also reviews the background of certain steps to be taken to keep the production going during times of acute water shortage.

To constantly monitor the water consumption pattern, a team was constituted comprising of members from different areas of production. Most important part of the exercise was, the top management gave its complete support for implementation of the water conservation measures. Also inputs from individual employees were invited.

Before going into real implementation, the need for conserving water was made known to all employees through handbills, recorded message in canteen during lunch hours and through display boards. Though depleting availability of water in the river was known, employees were made aware of reducing water consumption to targeted levels. This required round the clock surveillance, to check fresh water wastage in the process. Suprisingly, a wholehearted support of the management and the unstinted efforts of the employees could make the task of the team much simpler and our targets could be reached without much difficulty.

Before going into real action, a thorough audit of the water consumption, sectionwise in each area of production was done on a day to day basis. After estimating the average daily water consumption, targets were evolved to meet in steps. The break up water consumption, area wise is given in Table 1.

Table 1. Water balance

	m^3/day	
Paper machine 1	5000	
Paper machine 2	4700	
Pulpmill	22000	
Soft water	6000	
DM water	3000	
Others	6000	
Total	46700	m^3/day
Average production	620	Tonnes per day
Sp.water consumption	75	m^3/tonne of paper

Estimation of water consumption in various sections of the mill revealed that pulp mill was the major fresh water consumer. Sufficient water saving potential was available in pulp mill by way of reuse of process filtrates.

Process backwater available for reuse and their characteristics in different sections of the mill was determined. Based on their characteristics and availability several conservation measures were implemented. Before implementation, following aspects were ensured:

Replacing fresh water with the process back water in the specified area does not affect the product quality.

The effects of reuse of process back water in the specified area on chemical consumption and energy consumption.

Possibilities of scaling/corrosion due to reuse and modifications in plant and machinery with regard to material of construction.

Recycling measures and replacement measures were restricted to pulp mill, energy, environment and soda recovery only. No restrictions were imposed in paper machine.

The measures taken were classified under the following categories.

1. Permanent measures
2. Temporary measures
3. Emergency measures

Permanent measures were taken after totally confirming that the reuse measure will not have any negative impact in the process, product or machinery.

Temporary measures were taken during periods of water shortage for short period, which do have some impact in the process, product or machinery Emergency measures were taken when sufficient water resource is not available in the river, to sustain the mill's running, without stoppage, being fully aware of the negative impacts of the reuse scheme.

During the water crisis period, some extreme measures had to be taken, keeping in mind the after effects, so as to keep the mill running, without stoppage. The measures taken on a temporary basis were monitored continuously, which of course had some impact in the process.

Steps taken over the years to reduce fresh water consumption

Specific water consumption, which was on an average 120 m^3/tonne in 1999, was brought down to 98 m^3/tonne in 2001. This was by reuse of treated effluent water for

Milk of lime flash cooling.

Bagasse washing and Bagasse water channel make-up.

Lime mud filter and Effluent treatment plant filter vacuum pump sealing.

Boiler bottom ash quenching.

Pith press wire cleaning.

As a next step, the water consumption target was fixed at 85 m^3/tonne, which was also achieved by

Usage of chlorine backwater for screened pulp tower dilution and for cover showers.

Usage of excess foul condensate from soda recovery plant for brown stock washing in chemical bagasse street water. Continuous monitoring and metering water usage in areas where flow measurements were not available also helped in judicious usage of fresh water. Achieving the target of 65 m^3/tonne of paper was not at all difficult with implementation of aforementioned measures. Fig. 3 gives a picture of specific water consumption trend during recent times.

Impact of reducing fresh water usage in paper machine

Reducing fresh water increases accumulation if detrimental substances. Detrimental substances are non-ionic and anionic dissolved and colloidal substances. Anionic trash is a subgroup of detrimental substances. They consume retention aid and thus decrease Paper machine wire retention. Detrimental substances can absorb or precipitate onto the surface of Fibres, fillers and fines which adversely affect fibre to fibre bonding, brightness and accessibility of process chemicals.

Composition of detrimental substances

Sodium silicate	From Peroxide bleaching, de-inking, recycled paper
Polyphosphate	From filler dispersing agent
Polyacrilamide	From filler dispersing agent
Organic acids	From pitch dispersing agent
Carboxymethyl cellulose	From coated broke
Starch	From recycled paper, broke, strength agents
Humic acid	From fresh water
Lignin derivatives	From Kraft pulp, mechanical pulp, lignosulphonates when

	sulphite pulping is adopted.
Hemicellulose	From Mechanical pulp
Fatty acid	From Mechanical pulp

Organic dissolved and colloidal substances are excellent nutrients for microbial population and according to level of Dissolved Oxygen in process water either aerobic or anaerobic micro biological activity cause decreased system cleanliness by slime and smell. Slime deposits by anaerobic propagate corrosion because of the release of H_2S during the process.

Impact of reducing fresh water in pulp mill

Mill experiences have shown that the use of fresh water in bleach plant can be reduced without adversely affecting the pulp quality or bleaching chemical requirement and with significant savings in steam. This can be accomplished by reusing filtrates that would otherwise be sewered. Use of less water reduces fiber losses, BOD, COD and Color on per tonne basis and it concentrates the contaminants in wastewater and makes them easier to treat.

Precautions should be observed in applying water reuse measures since it can lead to corrosion problems, if corrosion resistant material of construction is not used. This is governed by the bleaching chemical used, conditions like temperature and cannot be generalized. It may be necessary to adjust the pH, increase or decrease the usage of certain bleach chemicals or make other process adjustments to correct for the changes caused by water reuse. In addition, water reuse may cause deposit problems.

Chlorination filtrate reuse

Reuse of the chlorination stage filtrate in dilution of brown stock Decker, high density storage towers, consistency adjustment and chlorine injection, results in an increase in chlorination temperature up to about 50°C.

At high chlorination temperature and high chloride levels, usually associated with chlorination filtrate recycle, it is essential to consume all chlorination chemicals before the pulp reaches the chlorine washer, if it is fabricated of 317 SS. Otherwise corrosion would be severe. Less corrosion has been reported when residual chlorine is zero. Because all of chlorine is consumed, chlorine saving which is significant compared with operation at low temperature. The bleach effluent is less acidic.

The hardness and Chloride content increase was evident during reduced water consumption. Detailed literature survey and our experiences indicated, to avoid sizing problems and deposit problems, the following levels in silo backwater by suitably purging and by fresh water make-up in the system have to be maintained.

Calcium hardness	Not more than 500 ppm
Chlorides	Not more than 350 ppm
Conductivity of backwater	Not more than 2800 mhos/cm
Acidity	200-250 ppm

These parameters could be maintained when incoming river water hardness was below 200ppm and chloride level was below 150 ppm. When water quality deteriorates as compared to this value, other measures have to be implemented which include polishing of machine back water with methods to purge dissolved solids and suspended solids. To prevent accumulation of detrimental substances in the system, Anionic trash catchers have to be added (these are normally part of RDA addition) so that these unwanted materials are kept under control, though some of the retention aids used act as anionic trash catchers. Scale preventing chemicals can also be dosed in case of heat exchangers and vacuum pump sealing water, during adverse water quality conditions.

Though dissolved material in the system do not cause machine runnability problems directly, problems caused during dewatering and pressing can cause breaks in the machine. However it may affect the system charge. Control of the system charge and unwanted accumulations can improve the machine performance even during poor water quality conditions. Our experience is that when we recycled the Paper machine effluent, the silo calcium level was building up and also the ionic load, which affected the sizing adversely.

Water conservation measures so far taken have been performed with literature guidance only.

Table 2 : Back water properties

Poperty		River water	Treated Effluent	Paper m/c backwater
pH		7.4	7.5	5.3
Colour PtCo.	ppm	0	260	0
Suspended solid	ppm	0	50	22
Total Dissolved solid	ppm	472	2399	1284
Calcium as $CaCO_3$	ppm	108	770	504
Magnesium as $CaCO_3$	ppm	100	80	90
Chlorides as Cl^-	ppm	74	895	324
Conductivity	μmhos/cm	646	3436	1917

The measures adopted are also being followed elsewhere in the industry. Critical areas such as bleached pulp washing, paper machine, stock preparation and paper machine vacuum pump systems and condensate systems have not been touched. However, due to adverse water quality in the river and during severe water shortage, paper machine effluent recycling was resorted to, to keep the machine running, maintaining the threshold levels of hardness and chlorides in water.

Corrosion aspects in pulp mill and paper machine have to be looked into and based on literature the water quality and the backwater quality are being monitored on a continuous basis and are maintained within the limits.

This results from a combination of less chlorine usage for chlorination and the change in chemistry of chlorination from oxidation to substitution, at lower pH with recycle. (4)

Chloride concentrations of 3000 ppm have not resulted in increased corrosion of 317 ELC SS. (5)

When the chloride concentration exceeds this level and temperature above 40°C as a bare minimum, type 317 ELC (with 3.9% Molybdenum) SS material is recommended. FRP or Polyester coated MS pipe can be substituted for 317 ELC. In addition to corrosion caused by residual chlorine, the problem is compounded by lower than normal pH and high chlorides.

Chlorination filtrate reuse in TNPL

Chlorination stage is one of the major water consuming stages in bleaching since it is performed at low consistency of 3%. Hence for diluting the stock from 10% to 3% usage of chlorination stage filtrate was resorted to, as a water saving measure. This was initially implemented in Chemical Bagasse Pulp street 2, which gave encouraging results with regard to decrease in chlorine consumption, without having impact on pulp properties. The chloride content was also monitored which reached 1600 ppm as against the maximum permissible level of 3000 ppm of chlorides as suggested in literature. However, since the material of construction in CB2 is 317 L, corrosion problem could be taken care. Problems were encountered due to corrosion of the welding joints of pipe lines which was subsequently taken care of and this could be due to the material used for welding joints. The cost benefit analysis of recycling chlorine filtrate is given in Table 3.

Based on this experience the recycling of chlorination filtrate was extended to Hardwood street and Chemical Bagasse street 1 also after making necessary changes in material of construction. The residual chlorine got reduced and chlorine consumption has also come down in addition to substantial fresh water saving. But when we go in for ECF bleaching the recycling can be done more efficiently as the chloride concentrations will come down substantially, as

Table 3 : Chlorination backwater reuse in pulp mill

Particular	With Pm/c filtrate	With chlorine filtrate
Chlorine applied kg/t of pulp	22.S	18.7
Residual Chlorine in filtrate ppm	66	9
CE kappa number	2.3	2.2
Bleached pulp brightness ISO	85.8	86.7
Bleached pulp viscosity cPs	12.1	12
Cost benefit: Basis 200 tpd bleached pulp		
Reduction in Chlorine kg/day		760
Reduction in Lime for pH correction		20
Reduction in water m^3/day		990
Cost reduction for 200 tpd, due to		
Lower chlorine dosage		Rs 5320
Lower Milk of Lime dosage		Rs 1732
Lower water usage		Rs 2475
Total		Rs 9527
Cost benefit (approx)		Rs 50/tonne of pulp

one molecule of chlorine dioxide which has three times more oxidizing power than chlorine. This means the consumption will be less to that extent and each chlorine dioxide molecule generates one chloride ion as against one molecule of chlorine generating two chloride ions. Thus for the same degree of bleaching, when part of the chlorine is substituted by chlorine dioxide or if only chlorine dioxide is used in the first stage, the chloride concentrations in the filtrate of the first bleaching stage will further come down, thereby making the recycling process more easy.

Other recycling measure implemented in pulp mill was the usage of foul condensate for pulp washing, which of course needs no monitoring, since foul condensate, waste generated from SRP, is sufficiently hot and better than soft water, except colour, which has no impact on washing performance.

Treated effluent water is being used for Bagasse storage, sprinklers and for Bagasse washing. No adverse effect has been observed so far since 2000.

Water recycling measures in Soda Recovery Plant

In Soda recovery MOL flash cooling with fresh water was replaced with treated effluent water. As envisaged, scaling was observed and it is being periodically de-caled.

Since the excessive ionic build up in the water affects the sizing, with the present incoming river water quality and bleaching sequence, water consumption below 85 m^3/tonne is not

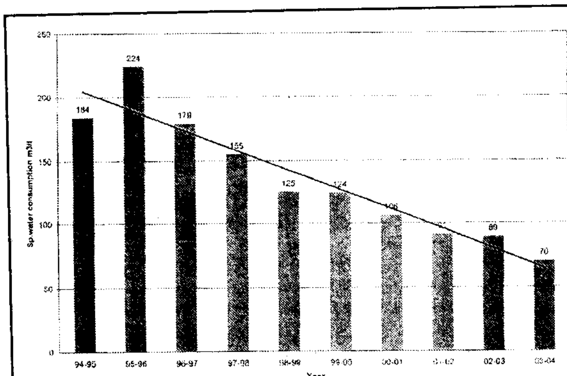

Fig. 1. Specific water consumption trend

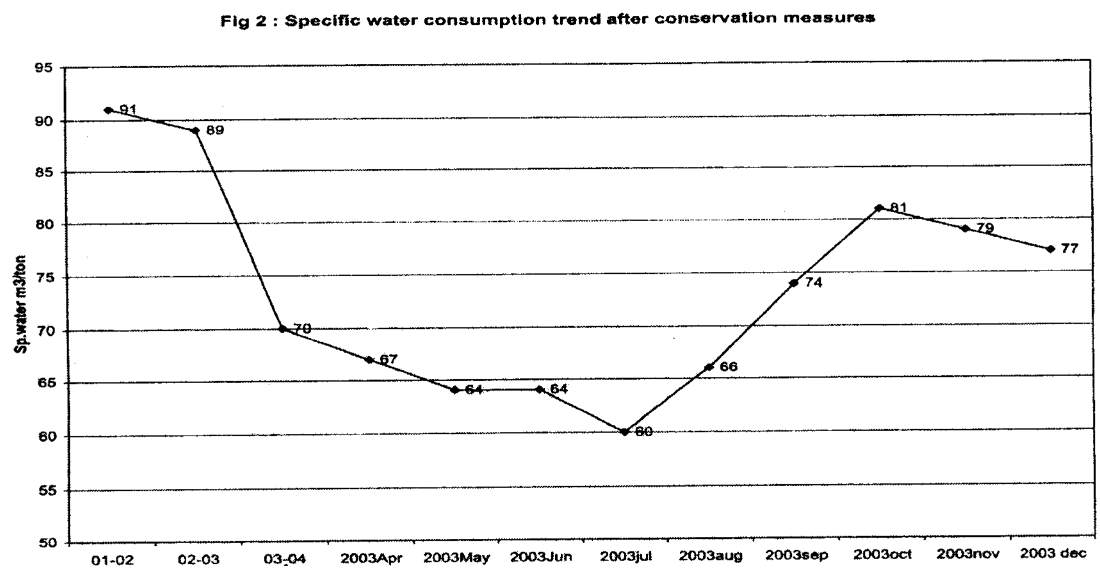

Fig. 2. Specific water consumption trend after conservation measures

recommended. This will take care of the sizing chemicals as well as bring down the TDS in effluents to the required levels.

- Fluctuations in incoming water quality are so high that it causes overloading of the Demineralization plant. To handle this ionic load fluctuations, installation of Reverse Osmosis (RO) plant for production of DM water for boiler feed can be considered.

CONCLUSION

Being environmentally responsible, making paper on an eco friendly way, with Bagasse as the chief raw material, TNPL is striving towards excellence in resource conservation. In this regard water conservation has been one of the steps. The achievement in water reduction was possible only through the commitment of the top management and through the support of the employees as a whole. In this regard the team places on record its sincere thanks to the top management and all the employees. The awareness was so deep that some days the specific water consumption went as low as 48 m^3/tonne of paper.

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