White Water Recycling - A New Concept

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INTRODUCTION

Pulp and paper industry is facing a major problem on account of increasing scarcity of water and the stringent discharge norms introduced by regulatory agencies.

This paper puts forward a new concept of white water recycling which provides the ideal solution to reduce the considerable amount of effluent discharge.

FOCUS

Present Scenario

Most of the Paper and Pulp mills use age old obsolete technology and machineries, and thus find it difficult to cope up with the change in scenario of stringent new regulations on disposable limits.

The critical problems being faced by the industry are:

Non-availability of conventional raw materials such as bamboo and wood, compel the use of raw material such as straw, jute, waste paper and bagasse. Since, the cellulose fibres in these unconventional raw materials are of inferior quality and yields low recovery of fibre from raw material, the quality of paper produced is inferior and not competitive in the market.

Since age-old technology is being practised, the manufacturing process consumes higher quantities of chemicals, water and other utilities, resulting in generation of large volumes of the highly contaminated effluent.

Most of the paper mills are situated on the banks of rivers. As water availability becomes scarce, Government regulatory agencies are introducing strict quality and quantity norms for effluent disposal, as their priority is to conserve good quality water for human consumption. To meet these statutory demands, paper mills are compelled to look in for superior technology to curtail the consumption of water and minimise contamination of the effluent.

Introduction of the Environmental Protection Bill and increased public awareness, empowers the common man to file a suit against any industry which is polluting the water resource, thus posing constant threat for survival.

PRESENT PRACTICE

Currently the average consumption of water per tonne of paper produced is in the range of 150-300 m^3 based on the type of the raw material and the manufacturing process being used.

Generally, all paper mills are equipped with conventional effluent treatment plants and discharge the treated effluent either in open nullahs or rivers.

However, over the past decade, some paper mills have begun using the treated effluent for crop cultivation, basically sugar cane, and in rare cases, for wheat and cereals.

However, this is not a solution because:

1. Huge quantities of effluent emanating from the paper industry demand large land for cultivation.
2. During the monsoon, there are severe problems of waterlogging if the treated effluent is discharged for crop cultivation. Hence,

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farmers are not interested in using the treated effluent for crop cultivation during the rainy season; the factory is compelled to discharge the treated effluent either into open nullahs or rivers.

3. The treatment cost of effluent.

   Ususally a paper mill spends about Rs.3-4 per cubic meter to treat effluent before discharge.

For example:

Effluent generated per tonne of paper	: 200 m^3 approx.
Treated cost per m^3 of effluent	: Rs. 3
Hence, cost of treatment of 200 m^3 of effluent	: Rs. 600/-
Average selling price of paper/tonne	: Rs. 18,000/-
% treatment cost on selling price	: 3.4
Assuming an average return per tonne of paper	: Rs. 5,000/- (say)
Implication of treatment cost on return	: 12%

These figures highlight to the reasons why effluent treatment plants are neglected by paper mills, leading to a "catch" situation. In other words, operation of effluent treatment plant adds to the paper cost but paper mill cannot increase paper price in order to be competitive in the market.

CHANGE IN SCENARIO

As the availability of water becomes scarcer, the government's priority is distributing water for domestic consumption and agriculture.

Hence it becomes critical to prevent the available water resources from getting contaminated with toxic chemicals. To achieve this, the following regulations have being imposed by regulatory agencies.

a. Environmental audit programs, to strictly control consumption and disposal.

b. Stringent disposal norms, directing industries to reduce discharge of effluent into common streams.

These new regulations in one way or the other compel industry to reduce it's consumption of raw water and control effluent discharge.

THE CONCEPT OF WHITE WATER RECYCLING

In the pulp and paper industry generation of effluent is from the pulp and paper section. The effluent (white water) from paper machines is easy to recycle since it is non toxic and contains only cellulose fibre debris as suspended solids in addition to valuable chemicals. Hence the major avenue for conserving raw water to control discharge and recover raw materials is white water recycling.

OBJECTIVES

The objectives of the treatment scheme are:

a. To conserve water by recycling

b. To reduce chemical consumption

c. To recover raw material (fibre) for reuse

d. To meet Pollution Control Board Standards for disposal

EQUIPMENT SELECTION

Equipment selection becomes critical to achieve the objectives since the recycled water from the fibre recovery system should be of such quality that it can be substitute fresh water, without any process/operational problems.

Hence, the design of the system should ensure:

1. Suspended solids less than 5-10 ppm in the recycled water so that it can be reused in paper machine showers without clogging the nozzles.

2. The clarifier used for solid-liquid separation should be capable of utilising the maximum quantity of chemicals that are added in the treatment process.

3. The recovered fibre should have adequate consistency so that it can be pumped directly to the machine chest or stock preparation.

4. The operation should be continuous and simple

and should also take care of the fluctuations in the white water quality during start-up/paper breaks.

5. The most important is that the equipment selected should be capable of handling fluctuations in terms of quality and quantity, to deliver consistently good quality recycled water, which can substitute raw water in machine showers.

AVAILABLE EQUIPMENT

The equipments used for the white water recycling are listed below:

1. Concrete Flotation Saveall.
2. Sedimentation Savealls or Clarifiers.
3. High Rate Solids Contact clarifier & continuous sand filter.

PRINCIPLE OF OPERATION

The principle of operation of two major equipments i.e. the Flotation Saveall and Clarifier are discussed below:

FLOTATION SAVEALL

Flotation savealls are based on the principle that solid particles will rise to the surface of a liquid if the liquid is loaded with air. Thus, in this type of saveall, air is mixed with waste water so that free air bubbles are produced when the pressure is reduced.

When the air is properly introduced, the bubbles are attached to the flocculated material and later, when the air is released, these bubbles cause the material to float to the surface.

The floated fibres are then removed by skimming.

To operate this unit properly :

a Air bubbles of appropriate size must be formed.

b. The fibrous and filler particles must be coagulated or flocculated and have their surfaces reduced in wettability before they can be removed by flotation.

c. The velocity must be between 3 and 5 cm/second in order not to break the flocs.

There are two types of flotation save alls. They are those that operate under reduced pressure and those that operate at atmospheric pressure.

Only the atmospheric pressure units are currently in operation in India.

LIMITATIONS OF THE FLOTATION SAVEALL

However, this technology too has limitations. When the feed to the Flotation Saveall fluctuates with respect to volume and suspended solids load, the clarified water from this Saveall is of inconsistent quality, with suspended solids varying from 50-200 ppm; thus the clarified water cannot be reused for critical applications. Hence, this technique helps only to reduce the water consumption between 15-20 m^3 per tonne of paper as against 50-100 m^3 to be conserved per tonne of paper according to the recent Pollution Control Board (PCB) regulations.

Thus there is an urgent need for a technology that can conserve water to the tune of 50-100 m^3 per tonne of paper to meet the stringent PCB disposal standards.

Clarifier followed by a Continuous sand filter can cater to this problem as will be explained later.

CLARIFIER

This clarifier operates on the same principle as in sedimentation of raw water but has some additional features which takes care of the peculiar problems of the Paper industry.

White water is first treated with a flocculant to flocculate the fine suspended matter, which is then settled out in basins equipped for the continuous removal of sludge.

The trend is towards integration of the mixing, flocculation and clarification stages in a single unit. In this process, a controlled amount of polymer is added to the white water as it enters the clarifier.

The intimate contact of the incoming treated water with the previously accumulated sludge tends to more effectively coagulate the solid matter in the water, since any newly formed precipitate tend to adhere to the previously formed precipitates, thus increasing the size of the particles.

Gentle mixing is provided to aid floc formation and also to maintain a uniform concentration of sludge. That part of the sludge which settles rapidly is drawn off at the bottom of the settling tank at a consistency of about 2-4%, while the clarified white water is removed by decanting.

The slower settling precipitate is drawn back into the mixing zone to aid the formation of new precipitates. According to Calsey, the effluent from this clarifier never exceeds 0.036 kg/m^3 (0.3 lb/1000 gal) of fibre under normal operating conditions, and the results are far superior to those obtained by ordinary coagulation and settling without contact with previously accumulated sludge.

This seeding effect of the previously formed sludge with the newly formed suspended particles in the white water, helps for consistent quality of clarified water from the clarifier, even at fluctuated inlet flow.

Chemical consumption also reduces due to effective utilisation of chemicals which otherwise would have been wasted along with the settled sludge.

With 30-50 ppm of suspended solids in the clarified water, the performance of the Continuous sand filter experience shows, will be less than 2-5 ppm, thus achieving the goal of recycling the white water for primary applications by substituting the raw water requirement.

BENEFITS OF CLARIFIER

A Clarifier suggested in place of a flotation saveall is capable of delivering uniform quality of treated water even when there are fluctuations in the inlet feed in terms of quantity and quality of white water - in this case, these fluctuations in quantity are between 100-250 m^3/hr and 900-2950 ppm. respectively.

At these fluctuation levels normally the flotation saveall usually fails to deliver consistent quality of water (ref: James Casecy under page no. 1252) because air flotation is not sensitive to temperature but is affected by large fluctuations in flow and solids loading.

BENEFITS OF CONTINUOUS SAND FILTER

As mentioned earlier, the treated water after fibre recovery, through a high rate solids contact clarifier will have suspended solids to the tune of 20-25 ppm thus cannot be used in paper machine showers since it may choke the showers resulting in damaging of the wire.

The concept of water conservation with fibre and chemical recovery will be defeated if the treated water cannot be reused in the paper machines.

Hence, to enable the recovered water from the recycling system to be used in paper machine, the Continuous Sand filter is used after the Clarifier.

Suspended solids in the clarified water usually be around 25-20 ppm. After passing through a continuous sand Filter, the filtrate will have less than 5 ppm. suspended solids so that the filtered water can thus be resued in the paper machine showers.

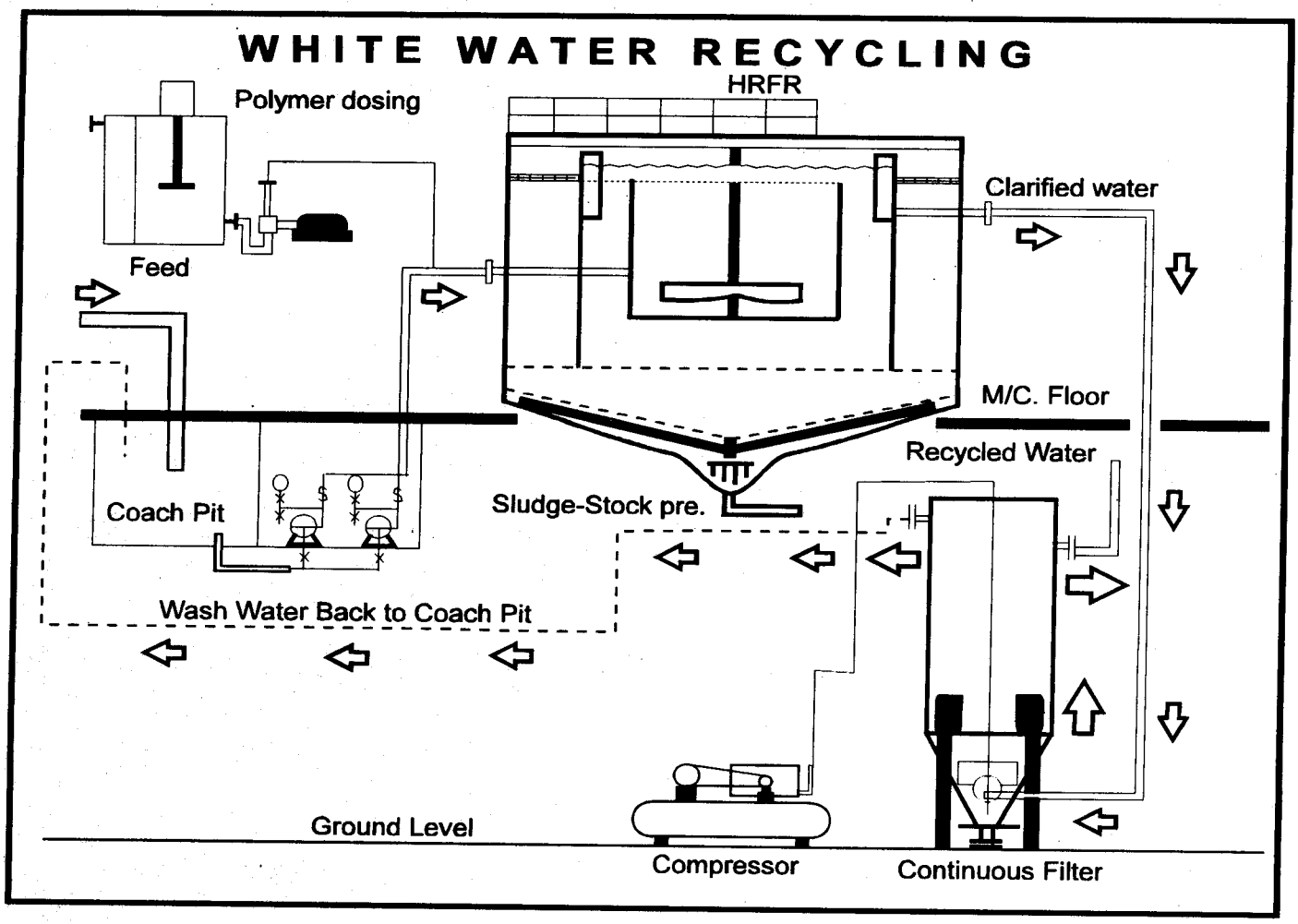
The continuous sand filter being a continuous filter, does not require stoppages for backwash. As it operates under gravity is really suited for use after a Clarifier which is also operated under gravity.

BENEFITS OF THE HIGH RATE SOLIDS CONTACT CLARIFIER - CONTINUOUS SAND FILTER SYSTEM

To achieve the best results regarding fibre recovery and water reuse, neither high rate solids contact clarifier nor continuous sand filter can provide the solution. It is the combination of these two units which meets the objectives of fibre recovery and water reuse.

The benefits of the above system vis-a-vis flotation saveall are highlighted below:

1. Load fluctuations-- The fluctuations in the suspended solids at the feed does not affect the performance of the above system. The filter serves



as a polishing unit after the clarifier which is capable of handling the fluctuations to deliver the consistent quality. Fluctuations in the inlet load condition will affect the performance of flotation saveall since the balance between suspended solids/ chemicals/ air dispersing ratio is very important and is very difficult to maintain.

2. Flow fluctuations-- Flow fluctuations do not affect the performance of the above clarifier - filter system. A flotation saveall does not tolerate flow fluctuations because of low retention time of the equipment.

3. Usage of recycled water-- The water from the above system can be used for primary applications such as wire cleaning, edge cutting etc. whereas water from a flotation saveall cannot be used for primary applications since the suspended solids in the treated water may go up to 50-200 ppm.