Installation and Operation of Effluent Treatment Plant at Seshasayee Paper and Boards

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SUMMARY

Seshasayee Paper and Boards Limited have installed an Effluent Treatment Plant to handle 15 million gallons of effluent per day. After primary treatment, the effluent is let out for irrigation purposes as the treated effluent conforms to IS : 3307 of 1965. The agriculturists who are using this treated effluent are satisfied with its performance. The design and operational problems faced by the mill in the installation of this effluent treatment plant and the solutions to these problems are discussed in this paper. Material of construction of effluent handling pumps and their design characteristics are of paramount importance in the successful running of effluent treatment plant.

In an integrated paper mill where there are three or four paper machines, the suspended solids in the effluent vary widely depending upon the exigencies of operation. In a mill like Seshasayee Paper and Boards which has four Paper Machines, one or the other paper machine will be stopped almost every alternate day for felt change, wire change, system cleaning etc. which causes widely varying suspended solids in the effluent and this aspect calls for extra attention to maintain the material balance in the effluent clarifier.

INTRODUCTION

As a part of its recently completed major expansion project, SPB installed a primary effluent treatment plant. This is one of the largest effluent treatment units in the country.

River Cauvery, on the banks of which the mill is located, is perhaps one of the most highly utilised rivers in the world and the impact of pollution is more keenly felt. The mill had therefore to implement an effluent treatment programme as a part of its social obligation.

The areas around the Mill are under extensive paddy cultivation. As early as the later part of the '60's, the mill had been under constant pressure from the neighbouring ryots to release the mill effluent for their irrigational use. On the directions of the District Collector the Mill had decided to discharge that part of its mill effluent for irrigation, which would conform to IS : 3307 (Tolerance Limits for Industrial Effluents discharged into Inland Surface Waters). The segregated stream which was being discharged for irrigational use was relatively free from suspended solids besides conforming to IS: 3307. The ryots used this effluent stream for their irrigational use over a period of 5 to 6 years, without noticing any undesir able influence, either on the soil or on the crop. In fact the mill was being persuaded to increase the discharge of effluent for irrigational use. But the mill opinied that it was undesirable to release the rest of its effluent without a primary treatment. Without primary treatment the mill effluent no doubt comes within the tolerance limits prescribed by IS : 3307.

However, it is the considered opinion of the mill that the suspended solids which are not prescribed by the IS standards can perhaps be the most objectionable constituent of the effluent stream. Continuous inflow of the suspended solids into paddy fields will result in silting of the soil thereby affecting its natural

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drainage properties besides interfering with plant growth. With this view, and encouraged by the favourable experience of the neighbouring ryots the mill decided to go ahead with its scheme for the primary effluent treatment and complete diversion of its treated effluent for irrigational use. The increased discharge of effluent has now enabled the ryots to maximise cultivation and extract additional crops wherever possible. The ryots are quite satisfied with the quality of the effluent made available to them for irrigation and the mill sees no reason why this method of effluent treatment and disposal should not work out on a long-term basis.

EFFLUENT TREATMENT

The effluent treatment plant installed in the mill has a capacity to handle 15 million gallons of effluent per day. The installation at present forms the primary stage of a two phase effluent treatment programme.

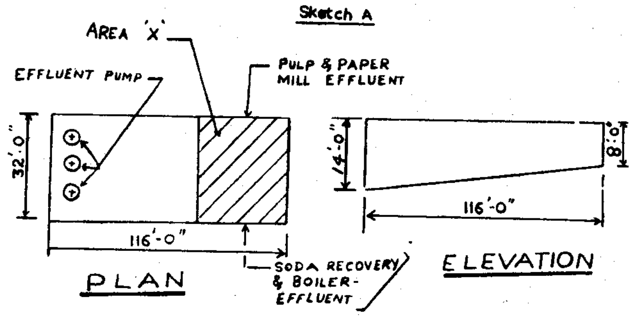
The effluent from different sections in the mill is collected in a central sump and then pumped to a 180′ dia clarifier equipped with a scum removal system. The clarifier was supplied by Hindustan Dorr-Oliver. The mixed effluent fed to the clarifier, had the following analysis :

Details	Untreated mixed effluent
pH	6.5 to 9.0
Total dissolved solids (inorganic), mg/l	400 to 1500
Suspended sulphates (as SO_4), mg/l	2 to 3
Suspended solids, mg/l	400-700
Chlorides (as Cl), mg/l	50 to 400
Percent Sodium	50 to 55
Biochemical oxygen demand for 5 days at 20° C, mg/l	200 to 250
Oils and grease, mg/l	14
Boron (as B), mg/l	Nil

Before finalising the equipment sizing, Hindustan Dorr-Oliver carried out extensive bench-scale tests at the mill to study the filterability of the sludge from mill effluent as also to size up design parameters for the clarifier and sludge filteration equipment. After the trials, Hindustan Dorr-Oliver recommended the use of lime sludge from the causticizing plant as a filter aid, since the underflow from effluent is otherwise slimy and does not lend itself favourably to filteration. The underflow from the clarifier at about 3 to 4% solids, is pumped to a mixing tank where it is mixed with lime sludge from the causticizing section and then sent to the belt filter. The filter cake has a thickness of ½″ and a miosture content of 55%. As this is the first effluent treatment plant of its kind to be installed and commissioned in India, very little guidance was available with regard to the equipment and its operation. The various mechanical and operational problems faced by the mill may be a guidance for other mills going in for effluent treatment in future. The principal equipment suppliers assisted the mill by working in close co-operation in overcoming most of the mechanical and operational problems.

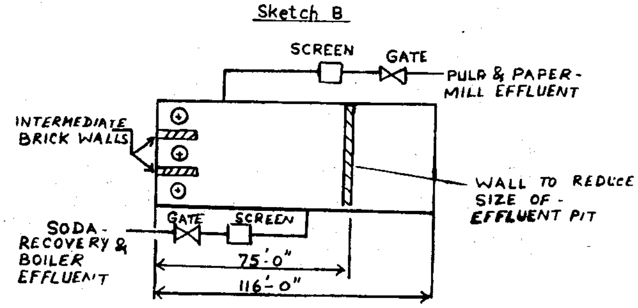
The collection sump for the effluent from various sections of the mill was originally designed to provide a retention time of around 8 to 10 minutes, as it was feared that the pumps may run dry, if this reteniton time was not available. It was also necessary to consider this retention time to take care of the wide fluctuations in the quantity of effluent flowing into the collection sump. We have, in our Mill, four paper machines and almost every alternate day there would be stoppage of one machine or the other for a wire change, felt change or order change when the quantity of effluent will be considerably reduced for a few hours. The collection pit originally designed had the following dimensions as indicated in *sketch A* below:

Sketch A



Within a week after mill started operating its effluent treatment plant, it was observed that the area marked 'X' in the *Sketch A* got filled up with settled solids, rendering that portion of the sump quite ineffective for retention. Hence it was decided to modify the Central collection sump as per *Sketch B* given below, thus reducing the retention time in the sump to about 6 minutes:

Sketch B



Along with this modification care was taken to ensure that the velocity of entry of the effluent into the sump does not exceed 1 ft. per second, as this approach velocity avoids turbulence near the affluent pumps. As can be seen from *Sketch B*, intermediate baffle walls had also to be constructed between the effluent pumps as a precaution against vortex formation, which affects the efficiency of pumping.

An automatic level controller installed in the pumping system has enabled the sump level to be constantly maintained within desired operation levels.

After the effluent treatment plant was put into continuous operation, it was observed that quite a lot of foreign materials were finding their way past the coarse screens into the effluent collection pit, clogging the strainer of the foot valves of the effluent pumps. The stationary screens initially installed, had to be replaced by self-cleaning type of bar screens with rotating comb arrangement. Even then, a coarse screen was required up-stream.

The experience in operation of the effluent plant for a few weeks indicated that the effluent pumps should have some basic constructional features for satisfactory performance. Our experience with vertical turbine pumps has been quite revealing.

(i) The impellers of effluent pumps should be of aluminium-bronze to handle a wide pH range between 6 and 9. The aluminium bronze impellers should be of very good casting, without any blow holes, for satisfactory performance.

(ii) The material of construction of the Bowl-bush bearing is important. If the material of construction is not proper, the bearing wears out very fast and excessive wear-out of the learing leads to complications like bending of the shaft and breakage of the impellers. After a series of trials with bronze and neoprene bearings, it was found that zinc-free bronze is the ideal material of construction for Bowl-bush bearings.

(iii) Even after identifying the most suitable material of construction for the impellers and bearings, there was still excessive wear-out of the pump parts and this was traced to what can be termed as "stagnation".

This stagnation is usually felt in vertical pumps which are constantly immersed in liquids containing an appreciable quantity of suspended solids which tend to settle between the bearings and the shaft of the pumps, or any other part of the pump where there is clearance between the parts. If these suspended solids are not flushed out, they will lead to rapid wear-out of the moving parts of the pump. This problem was overcome by providing a clean high pressure flushing water arrangement.

(iv) Strainers provided at the foot valves of the pumps were frequently getting clogged. After a few trials it was found that a 4" x 4" mesh was most suitable.

The effluent from the sump is pumped to the clarifier through a 24" mild steel pipeline. On account of the possible corrosion due to the wide pH range of the effluent, this pipe has been laid in an open channel to facilitate maintenance.

The bench-scale trials conducted by Hindustan Dorr-Oliver, indicated that it was advantegeous to add lime sludge for improving the filterability. It has also been established by laboratory trials carried out by the mills that if lime sludge is used for the treatment of effluent, there will be a reduction in the colour level of the effluent by 40-50 points on the platinum cobalt scale. When the mill started the effluent treatment plant, lime sludge was added in the clarifier along with the effluent. But serious problems were encountered on account of localised differential settling resulting in ineffective underflow removal and consequent overloading of the rake mechanism. As the overload on the rake mechanism was erratic, the practice of adding lime sludge to the clarifier has been temporarily discontinued and the lime sludge is now added only in a mixing tank where it is mixed with the underflow from the clarifier before filtering. However a systematic study of the solids input into the clarifier and the underflow extracted from it, revealed that there could be considerable difference between these two figures leading to accumulation in this clarifier. Once this factor was identified, it became necessary to keep a stricter control on the material balance by operating the underflow pumps suitably so that the clarifier functions normally without any overload.

As mentioned earlier, the suspended solids content of the effluent varies widely. Our effluent treatment plant was designed to handle an effluent with a suspended solids content of 400 ppm $\pm$ 150 ppm. Actually the effluent in our mill is now found to have a suspended solids content of around 600-700 ppm. But on a day there is a wire change, when savealls are cleaned or if there is some system cleaning in one of the paper machines, the solids content goes up as high as 1200 to 1300 ppm for a few hours. The extraction of underflow solids is therefore being strictly controlled to maintain a perfect material balance, on the basis of periodical determination of the solids in the inflow and outflow.

We have found by experience that conventional stock pumps of KMW type with SS impellers, are quite suitable for handling the clarifier underflow.

Our experience with the working of the clarifier has also shown that it is better to give a high pressure water and air connection to the bottom cone of the clarifier. Periodical flushing with high pressure water and air, helps in properly evacuating the underflow during times of unduly heavy accumulation and in keeping the suction of the underflow pumps clear.

The filteration unit of the effluent treatment plant supplied by Hindustan Dorr-Oliver comprises two belt filters 12′ dia x 20′. The filters are designed to handle 3 kg of filter cake per hour per square foot. The clarifier underflow mixed with lime sludge from causticizing section is filtered in these belt filters. Our experience indicates that the sizing factor could be higher, perhaps around 6 kg/sq.ft/hr. It has been found that it is advantageous to run these filters at a high RPM with a thin cake. At present the belt filters are run with a speed of 1/4 RPM yielding a cake with a thickness of 1/2″ and a moisture content of 55%.

The disposal of the effluent sludge from the belt filters as a land fill alone may not be a satisfactory long term solution. Further, disposal of effluent sludge as a land fill can constitute land pollution. SPB has attempted using the pulp from the underflow of effluent clarifier for the backling of duplex board. The trials carried out so far have revealed that this pulp can be advantageously used and the mill is now making arrangements to recover this pulp for use, on a permanent basis, in the backliner of duplex board.

The primary treatment plant is now in continuous operation without posing any serious operational problems. The operations have been stabilised at rated capacity with a performance as given in Table-I.

TABLE—I. THE TYPICAL ANALYSIS OF UNTREATED EFFLUENT, TREATED EFFLUENT AND TOLERANCE LIMIT

Sl. No.	Characteristics	Tolerance Limit as per IS : 3307	Typical analysis of untreated effluent	Typical analysis of treated effluent
1.	pH	5.5 to 9.0	6.0 to 9.0	6.0 to 9.0
2.	Total dissolved solids (inorganic), mg/l	2100 (max)	400 to 1500	400 to 1500
3.	Total suspended solids, mg/l	—	400 - 700	100 - 140 ppm
4.	Sulphate (as SO_4), mg/l	1000 (max)	2 to 3	2 to 3
5.	Chlorides (as Cl), mg/l	600 (max)	50 to 400	50 to 400
6.	Percent Sodium	60 (max)	45	45
7.	Biochemical oxygen demand for 5 days at 20 °C., mg/l	500 (max)	200 to 250	150 to 190
8.	Oils and grease, mg/l	30 (max)	14	14
9.	Boron (as B), mg/l	2 (max)	Nil	Nil