Zero Discharge for Textile Industry

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Introduction

The post liberalization period has led to the rapid growth of industrial output and exports in certain sectors. The cotton, textiles and garment industries in particular have grown due to availability of cheap labour and raw materials. However the bleaching and dyeing units in the textile industry have caused several environmental pollution problems. These units use large quantities of water, most of which is discharged in the form of effluents into land and water, polluting the local environment.

Untreated textile effluents released from these industries on open land seep into aquifers and increase the concentration of EC, TDS, Na & Cl contamination of ground water. Places with large numbers of dyeing units within the city such as Mathura (U.P.) and Pali (Rajasthan) have reported large scale contamination. In Tamil Nadu, ground water pollution is reported in Karur and Tirupur due to textile waste.

The water used in the process is almost entirely discharged as waste, the average being 150 to 175 litres of waste water for every kg of fabric processed. This poses a great demand for ground water. Untreated effluents contain substances that could endanger aquatic life. Some of the dyes present in the waste water are harmful to human beings and also to plants and animal. The ground water in Tirupur is highly brackish, resulting in damage to agricultural crops and has causing skin disorders.

All the above factors have impacted the socio-economic environment. Decreased agricultural production, degradation in the quality of drinking and irrigation water, shortage of water for irrigation have together affected the economy and the health of people in and around textile units all over India. Inadequate treatment of waste streams has also started to affect the business of units who mainly export to countries where a “green label” adds value and is now becoming mandatory.

The Honorable High Court, Chennai has compelled textile units in the region to set up treatment plants for implementation of zero discharge or face closure. Governments of various states are planning to follow suit soon.

This paper discusses an innovative treatment scheme incorporating state-of-the-art biological treatment systems in combination with membrane systems to tackle the two major problems facing the textile industry concerning waste water management:

1. Reduction of waste to a concentrated form to facilitate disposal either through mechanical evaporators or solar drying by maximising recovery. Brine from the second RO may also be considered for use in the dye bath for make-up.

2. Reduction in quantity of solid waste generated by the treatment process.
Conventional Treatment Process

Existing conventional treatment facilities comprises the following treatment scheme, which is a basic physico-chemical process generating enormous amounts of solid waste.

Typical Raw Effluent Characteristics

<table>
<thead>
<tr>
<th>Sr.No.</th>
<th>Parameter</th>
<th>Unit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>pH</td>
<td>-</td>
<td>8.6 - 9.0</td>
</tr>
<tr>
<td>2</td>
<td>Conductivity</td>
<td>µS/cm</td>
<td>15-16</td>
</tr>
<tr>
<td>3</td>
<td>Colour</td>
<td>Hazen</td>
<td>300-324</td>
</tr>
<tr>
<td>4</td>
<td>Turbidity</td>
<td>NTU</td>
<td>380-770</td>
</tr>
<tr>
<td>5</td>
<td>Total Dissolved Solids</td>
<td>mg/l</td>
<td>8040-8205</td>
</tr>
<tr>
<td>6</td>
<td>Total Hardness</td>
<td>mg/l</td>
<td>690-730</td>
</tr>
<tr>
<td>7</td>
<td>M-Alkalinity</td>
<td>mg/l</td>
<td>570-630</td>
</tr>
<tr>
<td>8</td>
<td>COD as O₂</td>
<td>mg/l</td>
<td>288-516</td>
</tr>
<tr>
<td>9</td>
<td>BOD as O₂</td>
<td>mg/l</td>
<td>75-145</td>
</tr>
<tr>
<td>10</td>
<td>SiO₂ as SiO₂</td>
<td>mg/l</td>
<td>40 - 46</td>
</tr>
</tbody>
</table>

ND: Not detected up to 0.1 mg/L

Innovative Biological Process for Textile Effluent Treatment

The biological treatment process outlined in this article in combination with membrane systems are now able to offer a comprehensive scheme for textile waste management.
The treatment plant will lead to a decrease in sludge which is one of the major problems in the CETP.

The treatment plant will also lead to almost 90% recycling of water, which can be reused in the process. This saves the input cost of fresh water and conserves depleting sources apart from solving the issue of waste disposal.

The dyeing wastes coming to the effluent treatment plant are collected in the equalisation tanks. Suitable aeration grids for air agitation are provided to keep the contents of the tanks in mixed condition. The effluent is homogenised and neutralised properly in these tanks, which will avoid shock loads on downstream operations and provide uniform organic and solid loading.

The equalised effluent is pumped to the LUCAS®-3 system for providing biological treatment. In LUCAS®-3, the organic BOD, COD and suspended solids are removed by means of micro-organisms and air. The organic material is converted into CO₂, water and new activated sludge.
The effluent will then flow by gravity to the INDION® High Rate Solids Contact Clarifier (HRSCC) for removal of suspended solids. Coagulants and INDION® Polyelectrolyte are dosed here to enhance the settling rates.

The effluent then flows by gravity to the Multigrade Filter (MGF). Chlorine is dosed here for removal of organics from the effluent. The effluent is then pumped to the INDION® Multigrade Filter for further polishing.

The INDION® Multigrade Filter will further remove suspended particles present in the effluent. The Multigrade Filter is a pressure sand filter with enhanced capabilities to remove suspended solids from the treated waste water as it passes through the sand bed.

The filtrate from the INDION® MGF fed to the INDION® Ultra filtration (UF) unit for further treatment.

INDION® Ultra filtration pretreatment is the best pretreatment technology for ensuring cost effective performance of the Reverse Osmosis (RO) System. INDION® UF is a unit operation often used to remove suspended solids, colloids, and macromolecules from liquid streams. As pretreatment to RO System, INDION® UF significantly increases the membrane life of the RO membranes and reduces cleaning frequency, thereby reducing operating expense for the RO System.

The concentrate from the INDION® UF system is recycled to the equalisation tank and the filtrate collected in the Ion Exchange Resin Column Feed Tank. The water is pumped from the Ion Exchange Resin Feed Tank to the INDION® Ion Exchange Columns for removal of colour bodies and also for reduction of hardness. The treated water is then collected in the RO Feed Tank.

RO feed water will then be pumped through a 5-micron cartridge filter. Micron filtration by cartridge filters will eliminate any foreign particles. The cartridge filters are equipped with 5-micron disposable cartridges, and the cartridge will be integrally wound polypropylene.

High Pressure Pumps are provided to feed filtered water at high pressure to the RO feed port. The INDION® RO system will operate at a recovery of 75-80%. The reject from this RO system will then be fed into another RO system using suitable membranes to recovered a further 50-60% of the reject stream, thus ensuring an overall recovery of around 90%.

**Sludge Handling System**

The minimal sludge generated from LUCAS®-3, INDION® HRSCC is collected in a common Sludge Sump, from where the effluent is pumped to the Centrifuge for Sludge Dewatering. The centrate from the Centrifuge is recycled to the Equalisation Tank.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Equalisation Tank</th>
<th>RO Permeate</th>
<th>RO Reject</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>-</td>
<td>8.58</td>
<td>5.8</td>
<td>9.13</td>
</tr>
<tr>
<td>Total Dissolved Solis</td>
<td>Mg/l</td>
<td>6000 – 8000</td>
<td>200- 400</td>
<td>60000 - 65000</td>
</tr>
<tr>
<td>Colour</td>
<td>Hazen</td>
<td>402</td>
<td>Nil</td>
<td>&lt; 35</td>
</tr>
<tr>
<td>Turbidity</td>
<td>NTU</td>
<td>311</td>
<td>0</td>
<td>15 – 25</td>
</tr>
<tr>
<td>Total Hardness</td>
<td>mg/l</td>
<td>980</td>
<td>Nil</td>
<td>&lt; 100</td>
</tr>
<tr>
<td>M.Alk</td>
<td>mg/l</td>
<td>600</td>
<td>40</td>
<td>-</td>
</tr>
<tr>
<td>Silica as SiO₂</td>
<td>mg/l</td>
<td>&lt; 20</td>
<td>0.5 - 1.5</td>
<td>&lt; 160</td>
</tr>
<tr>
<td>COD</td>
<td>mg/l</td>
<td>890</td>
<td>&lt;50</td>
<td>&lt;1500</td>
</tr>
</tbody>
</table>
LUCAS®-3 SYSTEM

Basics of Aerobic Waste Water Treatment

Waste water contains organic compounds. The quantity of organic compounds can be measured by a BOD (Biological Oxygen Demand) or COD (Chemical Oxygen Demand) analysis. It is the measurement of the amount of oxygen that is necessary to biodegrade (to oxidise) those organic compounds. Not all organic compounds are biodegradable.

Introduction

LUCAS® stands for: Leuven University Cyclic Activated Sludge Low-cost Unobtrusive Compact Advanced Sustainable

LUCAS® is a cyclic operating activated sludge system with a compact and modular design. LUCAS® combines the advantages of the conventional and the Sequencing Batch Reactor technology (SBR). Like in the conventional system, the reactor volume and the level in the tanks are always constant. It is a continuous system for both influent feed and effluent discharge. Like the SBR system, the reactor operates according to a time controlled process cycle that allows for the alternation of all essential processes (aeration, mixing, sedimentation) in a single compartment.

The advanced treatment leads to sustainability (effluent recycling). The biological reactor consists of three units. All units are hydraulically inter-connected and completely redundant.

By using the most advanced processes, in combination with the autonomous monitoring and controlling system the treated water will be continuously of the highest quality. This allows for safe effluent recycling for irrigation.

LUCAS®-3, typical layout
Advantages of LUCAS® technology

- The main advantages of the LUCAS® wastewater treatment process are the complete control flexibility and the optimal circumstances for all essential biological and physical processes:
  
  - organic oxidation,
  - nitrification
  - denitrification
  - biological phosphorus removal
  - aeration and mixing
  - sedimentation
  - sludge stabilisation

- Compact and modular: common walls, easy to extend.

- Continuous operation, continuous inflow, and continuous outflow: allows for use of smaller pump capacities and piping diameters.

- Constant reactor level: no need for moving weirs, simple construction.

- Constant reactor volume: 100% use of the volume, no changing pressures on walls.

- Identical reactor configuration: every compartment has the same size and the same equipment.

- Cyclic operation: every compartment follows a continuous process cycle, which gives an equal sludge distribution and an equal oxygen demand in every compartment. The optimal alternation of phases allows for the selection of well settling sludge flocs.

Main Advantages compared to Conventional Systems

- No need for external clarifiers, sludge scrapers, recycle pumps/screws/piping
- No extra disturbances in clarifier caused by sludge recirculation
- Optimal dynamics in substrate gradient and integrated selector effect, responsible for the formation of well settleable sludge flocs
- Control in time enables flexibility by adapting times for nitrification, denitrification, biological phosphorus removal, sedimentation, depending on influent characteristics
- Easy and very compact construction (no separate clarifier)
- Maximal redundancy
- Easy to cover
- Easy to extend, modular construction
- Common walls
Main Advantages compared to Sequencing Batch Reactors

- No raw wastewater enters a compartment in the phase preceding the sedimentation sequence. This guarantees optimal BOD, COD, N, P removal efficiencies, no short-circuiting.
- No head loss (volume is always used for 100%)
- Continuous influent and effluent flow means lower maximal flow rate and therefore smaller piping diameter and less installed capacity of pumps, aerators, weirs..
- No moving mechanical parts
- No varying pressure on walls
- Enables use of surface aerators
- Simplifies use of fine bubble aeration; no surpressor flow rate control based on water level is necessary

The LUCAS® system in combination with the established recycling process using UF, RO and resins provides a holistic solution to the water management problems of the textile industry.