Different method of spent wash treatment

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Present Guidelines/Directions for molasses distilleries:

1. Molasses based distilleries in India are now classified in “Red Category”.
2. As per the Charter for Corporate Responsibility for Environmental Protection (CREP-CPCB) all distilleries in India are now required to achieve Zero Liquid Discharge (ZLD).
3. Maximum storage of SW: 30 days in impervious tanks on concentrate SW basis. The impervious spent wash storage tanks and intermediate cooling and settling tanks has to be impervious and prepared as per the CREP norms with HDPE lining.
4. Bio-composting yard has to be impervious with leachate/run away collection sump well. The impervious bio-compost yard and ready bio-compost storage area has to be prepared as per the CREP norms with HDPE lining.
5. Storage of spent wash at any intermediate location and for utilizing in incineration boiler or bio-composting should not be more that 7 days equivalent of generation.
6. For 5 to 12 % solids containing spent wash, the filler material (PMC) to spent wash ratio prescribed is 1: 2.5 for 45 days cycle and 1:3.5 for 60 days cycle.

7. For concentrated bio-methanated spent wash (20 to 30 % solids), the filler material (PMC) to spent wash ratio prescribed is 1: 1.6 for 60 days cycle.

8. Impervious compost yard area based on material balance (plus ready compost storage area) should be made available.

9. During rainy season, bio-composting process has to be stopped.

10. However, bio-composting can continue provided covered compost yard of required area is available.

11. Record of filler material used (PMC) and bio-compost produced/sold should be maintained.

12. The quality of bio-compost produced should be certified by Ministry of Agriculture, GOI.

13. All non-process effluents such as Spent lees, Process condensates, RO permeate, CT blowdown, Softner/DM plant backwash, Pump gland cooling water etc. should be treated with CPU and recycled back.
14. On-line monitoring system should consist of following,

a) Two IP Cameras with night vision and $180^0$ rotation facility.

   One camera to be installed on Bio-composting yard and one at 30 days impervious spent wash storage lagoon.

a) Two mass flow meters to be installed. One mass flow meter to be installed at the raw spent wash generation point (Analyser column outlet) for measurement of raw spent wash generation and second mass flow meter to be installed after the evaporation (MEE) plant or before the 30 days spent wash storage lagoon for measurement of concentrated spent wash generation.

b) Both cameras and flow meters to be linked to state pollution control board and CPCB through the server of the vendor from whom the on-line monitoring system is purchased.
e) Stand-alone distilleries or distilleries having independent boiler should install on-line emission monitoring system (PM or depending on fuel being used) as per the CPCB guidelines.

15. All distilleries to identify recipient drains/ rivulets and their u/s & d/s locations in for monthly monitoring by industry to ensure ZLD from distilleries. The distilleries will get such samples analysed from EPA/NABL approved laboratories and the parameters to be analysed would be DO, Colour, BOD, COD, pH, and TSS.
**Bio-methanation:**
About 70 to 80% distilleries in the country have adopted bio-methanation of distillery spent wash as the primary treatment method. It is one of the well established technologies for distillery effluent treatment with excellent returns in terms of valuable biogas generation.

**Bio-methanation performance efficiencies**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>Slightly alkaline</td>
</tr>
<tr>
<td>BOD removal efficiency</td>
<td>85-90%</td>
</tr>
<tr>
<td>COD removal efficiency</td>
<td>60-65%</td>
</tr>
<tr>
<td>Specific biogas generation (NM³/kg of COD destroyed)</td>
<td>0.45 – 0.55</td>
</tr>
<tr>
<td>% of Methane in biogas</td>
<td>55-65%</td>
</tr>
</tbody>
</table>

**Output Conditions:**
1. Characteristics depends on above mentioned performance efficiencies.
2. Temperatures- 36-38°C for mesophilic reactors.
3. Volume remains the same.
Biomethanation:

✓ Reactor configuration; Either CSTR (Completely Stirred Type Reactor) or UASB (Upflow anaerobic sludge blanket) or Thermophilic.

✓ COD Loading rate: 5 kg/M³/day

✓ MOC of reactor: Mild steel

✓ Reactor should have external gas holder and necessary safety devices installed.

✓ Gas zone in the reactor and gas holder should have internal epoxy coating.
Reverse osmosis is a **membrane based separation technique**. A membrane is a selective barrier that permits the separation of certain species in a fluid by a combination of sieving & sorption mechanisms. The **feed stream** is physically split into **permeate** (or **filtrate**) comprising molecules that pass through the membrane and **reject** (or retentive or concentrate) that is composed of the molecules retained by the membrane.

### Reverse Osmosis Performance Parameters

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Particulars (Permeate characteristics)</th>
<th>From Raw spent wash</th>
<th>From Bio-methanated spent wash</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Permeate recovery, %</td>
<td>35-40</td>
<td>45-50</td>
</tr>
<tr>
<td>2</td>
<td>pH</td>
<td>2.9-3.5</td>
<td>6.8 - 7.2</td>
</tr>
<tr>
<td>3</td>
<td>COD, mg/lit.</td>
<td>620.0</td>
<td>119.5- 235.0</td>
</tr>
<tr>
<td>4</td>
<td>TDS, mg/lit.</td>
<td>400.0</td>
<td>200.0-350.0</td>
</tr>
<tr>
<td>5</td>
<td>TSS, mg/lit.</td>
<td>220.0</td>
<td>NIL</td>
</tr>
</tbody>
</table>
Design basis and broad specifications for Effluent Treatment Technologies:

Reverse Osmosis:

✓ RO configuration: Plate and frame
✓ Permeate recovery: Minimum 40 %
✓ Should have back wash / CIP system
✓ MOC of membrane should withstand the spent wash quality.
✓ Should have feed, permeate and reject flow measurement and totalizer devices.
The function of a MEE is to concentrate a non-volatile solute from a solvent, usually water. Depending on the number of effects used in an evaporator the quantity of water evaporated per kilogram of steam increases.

Performance Measures

✓ Main measures of evaporator performance:
✓ Capacity (kg vaporized/time)
✓ Economy (kg vaporized/kg steam input)
✓ Steam Consumption (kg/hr)
✓ Characteristics of process condensate (COD, BOD, TDS, pH etc.)
✓ Characteristics of concentrate (COD, BOD, TDS, pH etc.)
✓ Cleaning frequency and cleaning duration.
Output Conditions:
✓ Characteristic of concentrate will depend on the input characteristic of feed spent wash.
✓ General characteristic of process condensate can vary depending on the input characteristic of feed spent wash.
✓ Concentrate volume will depend on evaporation duty of the MEE plant.
Design basis and broad specifications for Effluent Treatment Technologies:

**Multiple Effect Evaporation:**

- **Water Evaporation duty:** It should be designed for the given water evaporation duty.
- **Evaporator types:** Falling film or combination of falling film and forced circulation types.
- **No of effects:** Minimum 5 effects with or without stand by body.
- **MOC:** SS 304 (for BMSW) or SS 316 (for Raw SW).
- **Should have feed, process condensate, steam condensate and concentrate flow measurement and totalizer devices.**
INCINERATION OF SPENT WASH

Incineration of concentrated spent wash along with some subsidiary fuel in a specially designed boiler is one of the potential technologies for achieving Zero Discharge. Concentrated spent wash at about 60% solids is fired in boiler along with subsidiary fuel such as coal or bagasse or other biomass. Either fluidized bed or travelling grate type of incineration boilers are in use. They can run for 300 or more days in an year.

Performance norms:
✓ It should result in Zero Discharge.
✓ The boiler should run at the rated capacity and at rated ratio of concentrated spent wash to subsidiary fuel.
✓ The incineration boiler should have installed necessary emission control system such as ESP or bag filters and should achieve the prevailing norms of boiler emissions.
✓ The boiler should have installed on-line stack monitoring system.
✓ The boiler cleaning frequency and cleaning duration.
Output conditions:

✓ Steam should be generated at rated capacity and pressure consistently.
✓ The ratio of concentrated spent wash to subsidiary fuel should remain constant.
✓ The ash generated should be disposed off properly.
Design basis and broad specifications for Effluent Treatment Technologies:

**Incineration boiler:**

- Should be designed for given concentrated spent wash feed rate.
- Should be designed for given concentrated spent wash to subsidiary fuel ratio.
- Should be designed for given steam pressure, temperature and output rate.
- Should have necessary emission control system as well as on-line monitoring system installed.
- MOC: To withstand the acidic nature of spent wash.
Biocomposting

Composting has come to be accepted as one of the good solution to the problem of distillery effluent treatment. Properly operated bio-composting can result in to zero effluent discharge. It can be used either as a secondary treatment after anaerobic digestion or as a tertiary treatment after concentration of spent wash.

**Performance norms:**
It should result in Zero Discharge.
There should be no odour or fly nuisance.
The finished product should be free from any repulsive odour.
The finished product should be baggable product, easy to handle and transport.
The BOD of 1 gram ready compost dissolved in 100 ml distilled water should not be more than 100 ppm.
Bio-compost characteristic should be moisture: < 35%, Organic Carbon: 20-25 %, C:N ratio : <17:1, Nitrogen: 1.5-2%, Phosphorous: 1.5-2%, Potassium: 2-3.5%, Total Volatile Solids: 50-60% on dry wt. basis.
Output conditions:
✓ Bio-composting process should result in Zero discharge.
✓ The resultant bio-compost of above mentioned quality should be stored on impervious yard.
✓ The bio-compost produced should be packed in polybags and the details of bio-compost quality and name of manufacturer should be mentioned on the bag.
Design basis and broad specifications for Effluent Treatment Technologies:

**Bio-composting system**

- Should consist of impervious spent wash storage tank and impervious bio-compost yard.
- Spent wash storage tank capacity: 30 days on the basis of concentrate spent wash generation.
- Should consist of leachate collection gutter all around the bio-compost yard as well as leachate recycle sump tank.
- Bio-compost yard: Area should be based on 60 days cycle and 4 cycles per annum.
- AeroTriler (mixing cum turning machine): Self propelling type with auto-spraying arrangement.
- Should also have loading/unloading as well as windrow dressing machines.
A molasses based distillery requires fresh water for the following processes

I  Process Application

a)  Yeast Propagation
b)  Molasses Preparation/Dilution
c)  Steam for Distillation

II  Non Process Application

a)  Cooling Tower Water blow down
b)  Treated Water for Liquor Preparation
c)  Water and Steam for Washing
WASTEWATER GENERATION IN DISTILLERY

I. Process Waste Streams
- Spent wash from Analyzer Column
- Fermenter Sludge
- Spent lees from Rectifier Column /PRC column/MSDH column
- Condensate from Spent wash Volume Reduction Unit
- Boiler Ash

II. Non - Process Waste Streams
- Cooling Tower Blow down
- Back wash water
- Water Treatment Plant Maintenance Water.
- Boiler blow Down
The molasses requirement for production of 1 KL of RS is between 3.57 – 4.237 MT depending on type of process, i.e. Continuous or Fed Batch Process.

The average water requirement of a molasses based distillery ranges between 8 – 10 m³ / KL of Rectified Spirit.

An additional 8-10 m³/KL of soft treated water is required for other purposes.

However, in practical context, the amount of fresh water required per day for a distillery ranges between 10 – 12% of total RS Production capacity.

The process of distillation results in release of large quantities of wastewater which has a considerable environmental impact.
The various types of process effluents generated during Alcohol production

A. Distillery spent wash

- Distillery spent wash is one of the 17 most high strength wastewater streams which are described by the Central Pollution Control Board.
- It is a wastewater stream generated from the primary column of the distillation process, i.e., the Analyzer column.
- The average generation of the spent wash in a distillery ranges between 8 – 10 L/L of alcohol produced.
The average characteristics of spent wash are as given below.

**CHARACTERISTICS OF DISTILLERY SPENTWASH**

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Characteristics</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>pH</td>
<td>4.3 – 5.3</td>
</tr>
<tr>
<td>2.</td>
<td>Total Solids (mg/L)</td>
<td>60000-90000</td>
</tr>
<tr>
<td>3.</td>
<td>Total Suspended Solids (TSS) (mg/L)</td>
<td>2000-14000</td>
</tr>
<tr>
<td>4.</td>
<td>Total Dissolved Solids (TDS) mg/L</td>
<td>67000-73000</td>
</tr>
<tr>
<td>5.</td>
<td>Total Volatile Solids (TVS) mg/L</td>
<td>45000-65000</td>
</tr>
<tr>
<td>6.</td>
<td>COD</td>
<td>70000-98000</td>
</tr>
<tr>
<td>7.</td>
<td>BOD</td>
<td>45000-60000</td>
</tr>
<tr>
<td>8.</td>
<td>Total Nitrogen as N</td>
<td>1000-1200</td>
</tr>
<tr>
<td>9.</td>
<td>Potash as K2O</td>
<td>5000-12000</td>
</tr>
<tr>
<td>10.</td>
<td>Phosphate as PO4</td>
<td>500-1500</td>
</tr>
<tr>
<td>11.</td>
<td>Sodium as Na</td>
<td>150-200</td>
</tr>
<tr>
<td>12.</td>
<td>Chlorides as Cl</td>
<td>5000-8000</td>
</tr>
<tr>
<td>13.</td>
<td>Sulfates as SO4</td>
<td>2000-5000</td>
</tr>
<tr>
<td>14.</td>
<td>Acidity as CaCO3</td>
<td>8000-16000</td>
</tr>
<tr>
<td>15.</td>
<td>Temperature (After Heat Exchange)</td>
<td>700C – 800C</td>
</tr>
</tbody>
</table>
B. DISTILLERY CONDENSATE

- Spent wash volume is reduced through the process of spent wash concentration. This process is carried out through multi effect evaporation techniques.

- A variety of volume reduction techniques are available for spent wash concentration like Reverse osmosis, multi-effect evaporation (MEE) etc.

- The widely used method of spent wash concentration is multi-effect evaporators, which compared to the reverse osmosis techniques, are more efficient and have lesser recurring costs.

- In the process, the due to evaporation, condensate is generated in the calendria of each evaporator body which is used for many purposes after treatment.

- Theoretically, this water is more or less looks pure. However, since the MEE process works under vacuum, any changes in the vacuum settings can cause significant entrainment in the vapors. Also, spent wash contains large amount of volatile products, because of which, the condensate is often entrained by the volatile organics which cause increase in the COD of the water.
## CHARACTERISTICS OF DISTILLERY CONDENSATE

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>Observed values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>Clear</td>
</tr>
<tr>
<td>Color</td>
<td>Transparent</td>
</tr>
<tr>
<td>Odour</td>
<td>Unpleasant</td>
</tr>
<tr>
<td>pH</td>
<td>3.57-4.0</td>
</tr>
<tr>
<td>Conductivity</td>
<td>940 -1000µ S</td>
</tr>
<tr>
<td>Total solid</td>
<td>4.0-4.5 mg/l</td>
</tr>
<tr>
<td>Suspended solids</td>
<td>0.55 -1.0mg/l</td>
</tr>
<tr>
<td>Ammonia</td>
<td>below detectable limit</td>
</tr>
<tr>
<td>Volatile fatty acids</td>
<td>2000-3000 mg/l</td>
</tr>
<tr>
<td>Sp. Gravity</td>
<td>1.0012-1.0020</td>
</tr>
<tr>
<td>COD</td>
<td>3500- 4200 mg/l</td>
</tr>
</tbody>
</table>
C. DISTILLERY SPENT LEES

- Spent lees is another type of effluent which is generated from the Recovery columns of the distillation process.
- The effluent is mainly characterized by rogue alcohols, which get entrained in the spent lees due to change in the conditions of the columns, which thereby affect the parameters of the stream significantly.

CHARACTERISTICS OF DISTILLERY SPENTLEESSE

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume (%)</td>
<td>upto 250 %</td>
</tr>
<tr>
<td>C.O.D. (mg/L)</td>
<td>8000 – 16000</td>
</tr>
<tr>
<td>B.O.D.5 (mg/L)</td>
<td>4000 – 8000</td>
</tr>
<tr>
<td>TDS (mg/L)</td>
<td>5000- 6000</td>
</tr>
<tr>
<td>TSS (mg/L)</td>
<td>500- 1000</td>
</tr>
<tr>
<td>Chlorides (mg/L)</td>
<td>50-100</td>
</tr>
<tr>
<td>pH</td>
<td>3.6 - 4.5</td>
</tr>
</tbody>
</table>
Check Points: To assess the usage and discharge of water/waste water from various unit operations:

- Tube well
- Flow meter 1
- Total water requirement
- Flow meter 2
- Fermentation dilution
- Sludge waste
- Biocompost/Sell
- Spent wash
- Flow meter 3
- Mass flow meter 1
- MEE
- Mass flow meter 2
- Slop
- Boiler
- Ash waste landfill
- Condensate
- CPU inlet
- Flow meter 5
- CPU outlet
- Boiler
- Ash waste landfill
Thank you