Treatment of Distillery Spent wash
Sugar Mill 

Sugar Cane → Sugar Mill → Sugar 

Sugar Mill → Spent wash 

Sugar Mill → Bagasse 

Sugar Mill → Molasses 

Distillery 

Sugar Cane → Distillery → Alcohol 

Distillery → Spent wash
Flow Sheet For a Molasses Fermentation and Distillation Unit (Sheehan and Greenfield, 1980)
Molasses Distilleries

• Spent wash is the main waste stream
  – It has a BOD₅ of about 30,000 to 60,000mg/lit
  – COD of about 1,00,000 mg/lit
  – pH – acidic (4 – 5)
  – Colour- dark brown
  – About 15% solids content
  – Ash contains Potash as K₂O
• Spent wash generation: about 8 to 15 litres per litre for alcohol produced

  • 8 for new plants
  • 15 for old plants
BOD Pollution load of all distilleries put together in India is more than 6 times the BOD load of the entire population of India.
Attempts with Spent Wash

• For washing sugar cane
• For diluting molasses
• For irrigating sugar cane fields
• For manufacturing cattle feed
• For manufacturing yeast / dry ice / etc

Nothing turned to be sustainable / feasible
Target Pollutants

- Organic matter
- pH
- Colour
WASTE TREATMENT ROUTES

• Biological – for sure, THE BEST option
  – More eco-friendly
  – End products acceptable to the nature
  – Low expenditures
  – But slow, more uncertainty, affected by weather / temp

• Chemical – for lesser quantities

• Thermal-
  usually costlier, probability of pollution, controversial but very fast, compact reactors, less area required, more fool proof, not affected by weather / temperature, less uncertainty
BIOLOGICAL WASTE TREATMENT

• Biological Reactors

  – Aerobic: ASP (Activated Sludge Process), TF (Trickling Filter), RBC (Rotating Biological Contactor)

  – Anaerobic: Conventional Digester, Di-phasic digestion, UASB, FB, Hybrid reactor

  – Composting (aerobic / anaerobic)
Organics + O₂ → CO₂ + H₂O + Biomass
Organic carbon, N, P
Return Activated Sludge
CO₂
AEROBIC TREATMENT
O₂
Waste sludge
Treated effluent
to sludge treatment
More Biomass
Organic carbon 100%

No oxygen
Different organisms in action

Biogas (CH$_4$ + CO$_2$ + H$_2$S)

Biomass > 10%

<90%
Comparing aerobic – anaerobic techniques

• Aerobic
  • Faster reaction kinetics
  • Hence smaller reactors
  • No bad odour

But
  • have to provide Oxygen
  • No any recovery,
  • more sludge to be handled
• Anaerobic

  • Fuel Gas recovery
  • Less sludge to be handled
  • No oxygen to be supplied

But

  • Slow reaction kinetics
  • Large reactors
  • Odour issues are there
The main treatment strategy

- $\text{BOD/COD} = \frac{45,000}{1,00,000} = 0.5$

Hence biological treatment is effective

Since it is **high strength waste water**, anaerobic treatment technique is better
Treatment strategy for sewage?

• $\text{BOD} / \text{COD} = 250 / 400 = > 0.5$

• Hence biological treatment is effective

• It is low strength waste water and hence aerobic treatment techniques are better
Spent wash treatment

- Anaerobic digestion was the mostly tried option: anaerobic digester, diphasic anaerobic digester, UASB, Fluidized bed anaerobic filter, etc.
This effluent cannot be disposed off to a river or sewer line or ocean

Disposal Standard = 30 mg/L for disposal into surface waters
pH adjustments

Raw Spent Wash
BOD =45,000 mg/L

Anaerobic reactor

Effluent
BOD about 3000 – 4000 mg/L

sludge

ASP

Effluent
BOD < 30 mg/L

Colour persists

Aeration tank

sludge
Raw Spent Wash
BOD = 45,000 mg/L

pH adjustments

Anaerobic reactor

sludge

Adsorption tower

Effluent
BOD < 30 mg/L

ASP

Aeration tank

sludge
Anaerobic digestion

Macro-molécules

Monomères

B. hydrolytiques

Acides organiques, alcools, ...

B. acidogènes

Acétate

B. acétogènes

CO₂+H₂

B. homoacétogènes

CO₂+CH₄

A. méthanogènes acétoclastes

CH₄

A. méthanogènes hydrogénophiles

Hydrolyse

Acidogénèse

Acétogénèse

Méthanogénèse
Conventional Anaerobic Digester

- **Influent**
- **Effluent**
- **Biogas**
- **Sludge**
UASB (Upflow Anaerobic Sludge Blanket) Reactor
Anaerobic Fluidized Bed Reactor (AFBR)
Anaerobic Digestion: 2 steps

Fresh sludges

55 °C
2 - 3 d

Heat exchanger

35 °C
8 - 12 d

Digested sludges

Hydrolysis + Acidogenesis

Acetogenesis + Methanogenesis
• Anaerobic digestion bring the BOD down to about 2000 – 4000 mg/lit
• But the discharge standards are normally much lower (20 or 30 mg/lit)
• Hence normally aerobic systems are used to bring the BOD down to < 20 or 30 mg/lit
• Unfortunately colour still persists!
• Then go for an Adsorption Tower using activated Carbon
• Hence the process becomes costly
Problems with Anaerobic Systems

- Requirement of ‘polishing’
- Uncertainty involved with biological systems
- Influence of external parameters like weather, temperature
- Requirement of energy intensive secondary treatment
• Colour problem still persists
• Need for tertiary treatment like adsorption
• CH₄ generated in the first step is used in the subsequent steps
• Much slower than thermal systems
• More space/volume required